GROUND-WATER RESOURCES OF EASTERN SCHENECTADY COUNTY, NEW YORK

With Emphasis on Infiltration from the Mohawk River

By
John D. Winslow, Herbert G. Stewart, Jr.,
Richard H. Johnston, and Leslie J. Crain

U. S. Geological Survey

STATE OF NEW YORK
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Prepared by

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
in cooperation with

CITY OF SCHENECTADY,
TOWN OF ROTTERDAM, and
NEW YORK WATER RESOURCES COMMISSION

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ABSTRACT

Most of the water supplies in eastern Schenectady County are from ground-water sources, the most productive being glacial deposits of sand and gravel. Other unconsolidated deposits supply small housing developments locally and most of them generally yield enough water for domestic purposes. The bedrock in the area generally yields only enough water for domestic supplies. Coarse sand and gravel deposits underlying the flood plain of the Mohawk River west of the city of Schenectady are the best source of ground water in the area. Individual wells in these deposits, at the adjacent Schenectady and Rotterdam well fields, have yielded up to 3,500 gpm (gallons per minute). These two well fields may be considered as a single center of pumping which was being pumped at an average rate of 16-18 mgd (million gallons per day) in 1960-63. Most of the ground water pumped at these fields is infiltrated to the sand and gravel aquifer from the Mohawk River.

The yield of the sand and gravel aquifer is limited mainly by the seasonal range of temperature of river and ground water, and by the changes in river level for navigation purposes. Changes in temperature affect the viscosity of water in the river and in the ground and thus, the field coefficients of permeability of the silt and gravel on the riverbed and of the sand and gravel aquifer. When the river temperature is above 32°F, the field coefficients of permeability of the riverbed materials and aquifer vary, but are high enough to permit infiltration of enough water to meet the pumpage requirements at the Schenectady and Rotterdam well fields. When the river temperature is at or below 32°F, the field coefficient of permeability of the riverbed materials is low and constant, and the rate of infiltration is less than 16 mgd, or not enough to meet the pumpage requirements. As a result, part of the pumpage is derived from storage in the aquifer. When the river temperature is above 32°F, the river level above Lock 8 is high a large part of the time and infiltration to the aquifer is mostly from above the lock; when the temperature is at or below 32°F, the river level is low and most of the infiltration is from below Lock 8. For short periods of time when the temperature is at or below 32°F, the river level above Lock 8 is raised and the head is sufficient to induce infiltration which replaces some of the ground water removed from storage.

The chemical quality of ground water in eastern Schenectady County is satisfactory for most purposes. The water is generally hard and varies from 1 to 540 ppm (parts per million) of dissolved mineral constituents.

Ground-water pumpage in eastern Schenectady County in 1961 averaged about 21 mgd. Of this amount an average of nearly 18 mgd was pumped at the well fields of the city of Schenectady and the town of Rotterdam.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

Most of the water supplies in eastern Schenectady County are obtained from ground-water sources. Withdrawal of ground water in 1962 averaged about 21 mgd (million gallons per day), almost all of which was from wells in the unconsolidated deposits overlying bedrock. About 18 mgd was pumped from the adjacent well fields of the city of Schenectady and the town of Rotterdam. These two well fields draw water from coarse sand and gravel deposits beneath the flood plain of the Mohawk River about two miles west of Schenectady. Water pumped from the wells of other public water supply systems, of industrial systems, and of individual home owners accounts for the remaining 3 mgd. The population of the area has steadily grown through the years, and public officials have become increasingly concerned that the demand for water might soon exceed the supply available from existing sources. Thus, it has become important to determine the maximum perennial yield of existing well fields and to locate areas in which additional supplies of ground water can be developed. The purpose of this investigation was to collect and interpret data pertaining to the occurrence of ground water in the more populated eastern portion of the county with respect to the availability and quality of the water. Special attention was devoted to the deposits along the Mohawk River in which large supplies of ground water are available through infiltration of water from the river.

The investigation of the ground-water resources of eastern Schenectady County was made by the Water Resources Division, U.S. Geological Survey, in cooperation with the city of Schenectady, the town of Rotterdam, and the New York Water Resources Commission. This report is one of a series describing the investigations of the U.S. Geological Survey in various areas of the State. The areas of the State in which studies have been completed or in which work now is in progress are shown in figure 1.

The investigation included collection and analysis of the records of about 700 wells and test holes, chemical analyses of water from representative wells, and a study of the geology of the unconsolidated deposits. The records of selected wells and test holes are shown in table 9, their locations are shown in plates 1 and 2, and the logs of many of the wells are shown graphically in figure 33. The water-bearing characteristics of the aquifers were calculated from the results of pumping tests conducted on wells drilled for public or industrial water supplies.

The amount of ground-water recharge from precipitation was calculated for the Schenectady area by Thornthwaite's water-balance method (Thornthwaite and Mather, 1957) and related to the surficial deposits. From the results

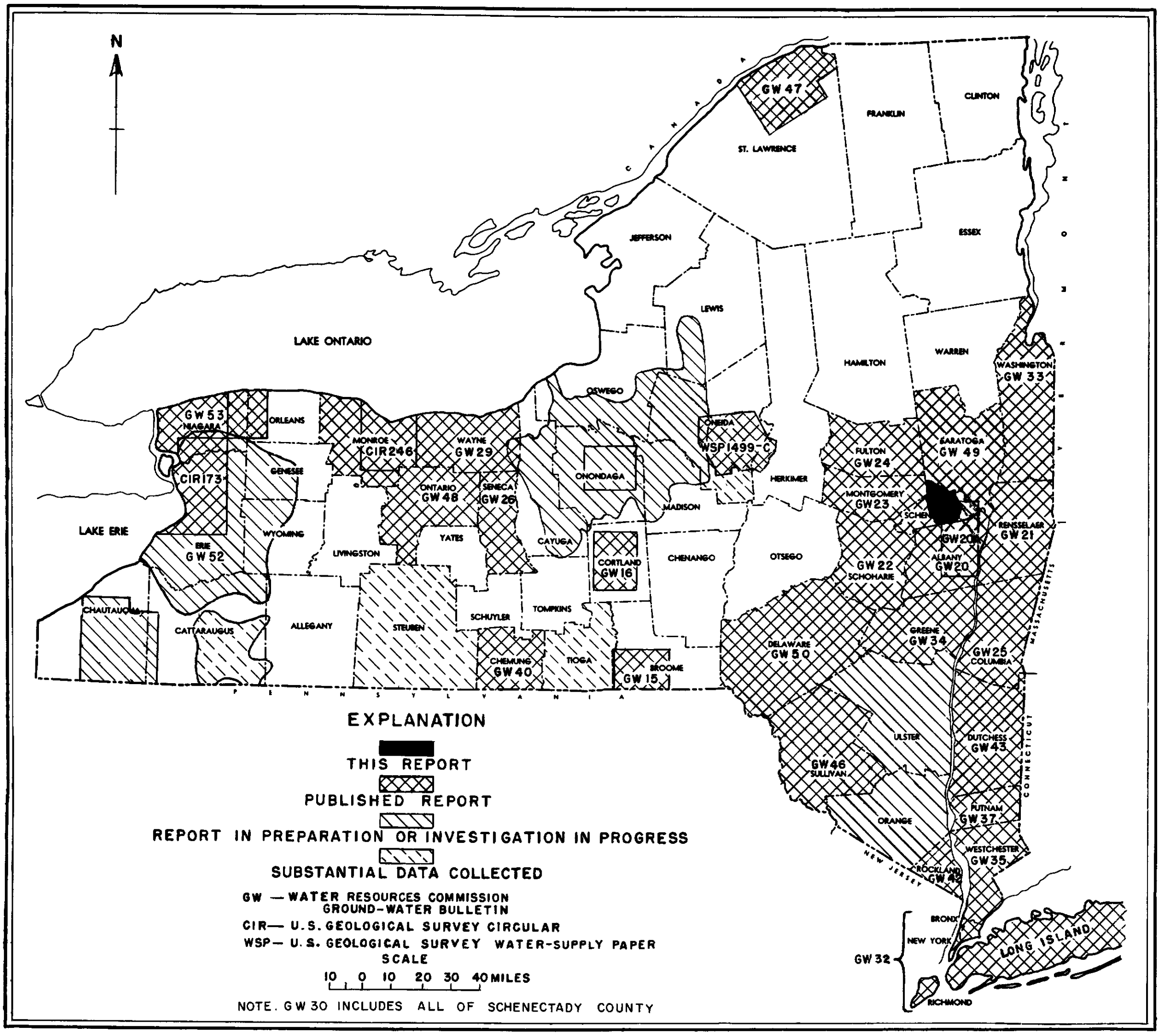

Figure 1.--Index map of New York showing location of eastern Schenectady County, and the status of ground-water investigations.

of these calculations the amount of natural recharge to the aquifers of the area can be estimated, thereby providing information as to the safe yield of wells on an areal basis.

Water-level and water-temperature data were collected periodically in many wells in the vicinity of the Schenectady and Rotterdam well fields so that the hydrologic factors governing infiltration from the Mohawk River could be studied. Such studies provide a basis for estimating the maximum perennial yield of these well fields and of others with a similar hydrologic setting. Observation wells were drilled in the area surrounding the Schenectady and Rotterdam well fields to provide additional information on the variation of lithology and on the areal extent of the aquifer, and to provide better coverage with respect to water-level and ground-water temperature data.

LOCATION AND POPULATION

The area described in this report includes the towns of Glenville, Niskayuna, and Rotterdam, the city of Schenectady, and the village of Scotia. For convenience, the area is referred to as eastern Schenectady County. On the U.S. Geological Survey topographic maps, eastern Schenectady County occupies parts of the Burnt Hills, Niskayuna, Pattersonville, Rotterdam Junction, and Schenectady 7 1/2-minute quadrangles.

The political subdivisions are shown in figure 2, and the population and area of these subdivisions are shown in the table below. The names of some places referred to in the text are also shown in figure 2.

	Area (square miles)	Population 1/ 1950	Population 1/ 1960	Population density 2/ 1960
City of Schenectady	10.4	91,785	81,682	7,854
Village of Scotia	1.5	7,812	7,625	5,108
Town of Glenville 3/	49.5	2,300	18,082	365
Town of Niskayuna	15.2	6,133	14,032	923
Town of Rotterdam	37.5	13,450	27,493	733
Total	114.1	121,480	148,914	

1/ U.S. Bureau of Census
2/ per square mile
3/ excluding the village of Scotia

The effect of urbanization between 1950 and 1960 is clearly shown by the decrease in population of the city of Schenectady and the village of Scotia, and in the marked increase in population of the towns of Glenville, Niskayuna, and Rotterdam. Most of the population of the towns of Glenville and Rotterdam are concentrated on two lowland areas; one north of Scotia, and another south of Schenectady. The hilly areas in the western parts of these two towns have relatively small populations.

SUMMARY OF GROUND-WATER CONDITIONS

Most of the water supplies in eastern Schenectady County are from ground-water sources, principally from the more permeable of the unconsolidated glacial deposits which overlie relatively impermeable bedrock. Eastern Schenectady County has been divided into four hydrologic areas on the basis of the yield of wells and the water-bearing characteristics of the unconsolidated deposits. These are (1) areas where till or lake silt and clay overlie bedrock, and in which wells generally yield less than 5 gpm (gallons per minute); (2) areas of lake sands, in which the yield of wells is generally between 5 and 20 gpm; (3) areas where the principal water-bearing materials are flood-plain deposits or kame deposits, and in which wells generally yield between 20 and 100 gpm; and (4) areas of exceptionally permeable coarse sand and gravel deposits in which wells

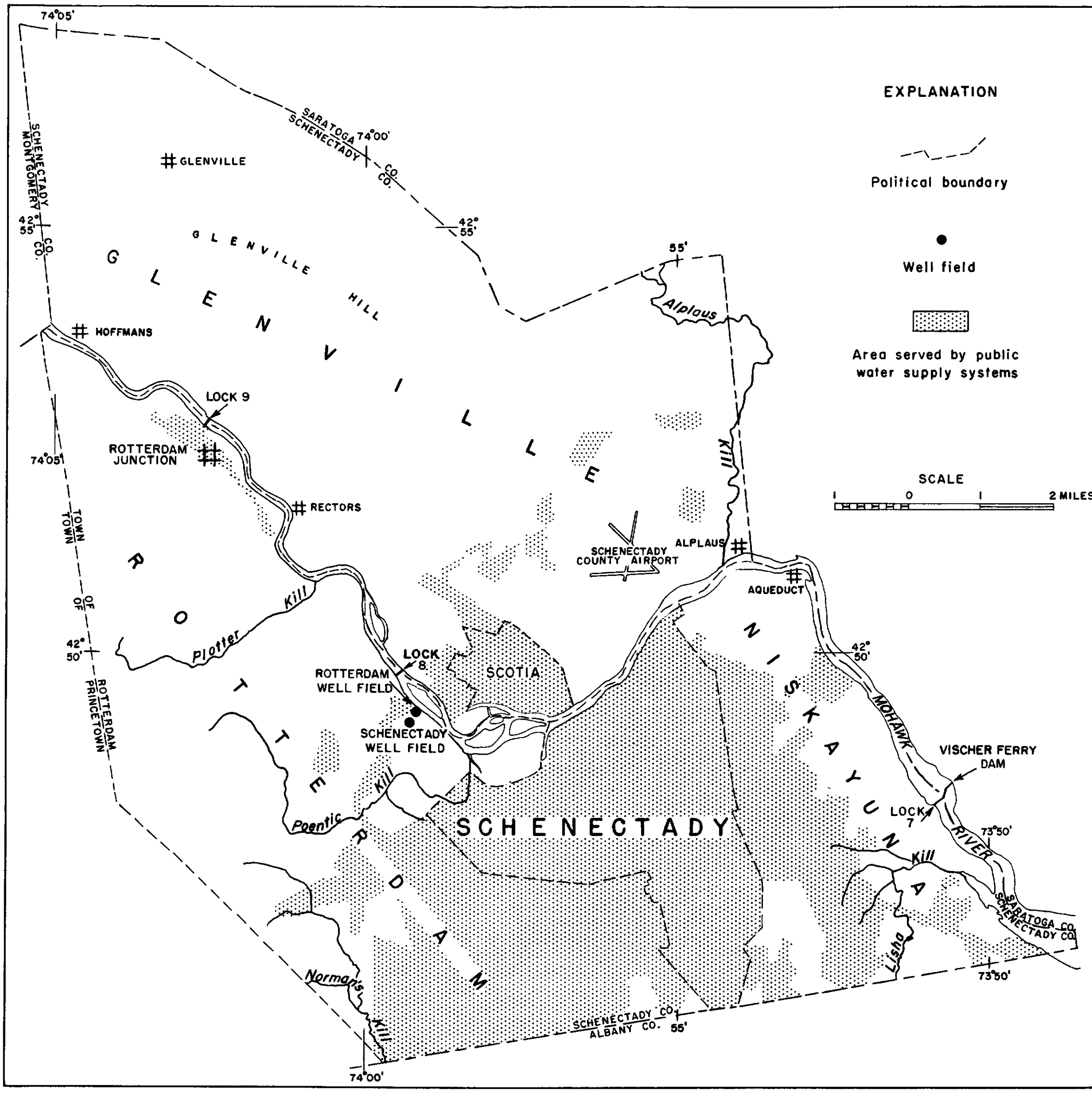

Figure 2.--Map of eastern Schenectady County showing political subdivisions, the location of some places referred to in the text, and the areas served by public water supplies.

generally yield more than 100 gpm and may yield up to 3,500 gpm. These hydrologic areas are shown in plate 1, which is a general guide to the ground-water resources of eastern Schenectady County.

All ground-water recharge in the area is from precipitation except in the Mohawk River valley and a few small tributary valleys where aquifers are recharged by infiltration induced from the streams. The amount of ground-water recharge from precipitation, based on the water-balance method

of Thornthwaite (Thornthwaite and Mather, 1955, 1957), is approximately 500,000 gpd (gallons per day) per square mile in the areas of sandy soils on the lowlands north of Scotia and south of Schenectady. The rate of ground-water recharge is substantially less in the areas where till is the surficial deposit. The safe yield of all the deposits not supplied by stream infiltration is limited to the ground-water recharge available from precipitation.

An average of 16-18 mgd of ground water, of the 21 mgd used in eastern Schenectady County in 1960-63, was from wells in a coarse sand and gravel aquifer at the adjacent well fields of the city of Schenectady and the town of Rotterdam. These well fields are located on the flood plain of the Mohawk River about two miles west of Schenectady. Of the water pumped at the city and town well fields, approximately 10 percent has its source as precipitation falling within the area of the cone of depression about the well fields and on the ridge to the west that drains toward the well field area. The remaining 90 percent was water infiltrated from the Mohawk River. The principal hydrologic factors controlling the infiltration to, and the yield of the aquifer are:

(1) The presence of silt and clay deposits of very low permeability on the riverbed, which retards the movement of water from the river into the aquifer.

(2) The temperature of water in the river and the aquifer, which causes seasonal changes in the field coefficient of permeability of the aquifer and riverbed materials.

(3) River level, in that:

a. the hydraulic gradient between the river and the aquifer is partly controlled by seasonal changes in river level for navigational purposes;

b. the location of the principal infiltration area also changes significantly due to controlled seasonal changes in river level for navigational purposes;

c. minor short-term fluctuations of river level above the controlled levels, caused by climatic factors and/or channel conditions, replenish storage in the aquifer.

(4) The permeability of the aquifer, including differences in permeability from zone to zone within the aquifer.

(5) The volume of storage available in the aquifer, which supplies part of the yield when pumping exceeds infiltration.

(6) The saturated thickness of the aquifer which affects the transmissibility and limits the drawdown available in wells.

The aquifer is composed of two layers, an upper layer of coarse sandy gravel which ranges in thickness from 35 to 50 feet and a lower layer of sand which ranges in thickness from 0 to about 30 feet. The aquifer is underlain by glacial till which overlies shale bedrock. The permeability of the coarse sandy gravel is extremely high and locally may exceed 500,000 gpd per sq ft. The average permeability is probably on the order of 100,000 gpd per sq ft. The permeability of the sand layer probably does not exceed 1,000 gpd per sq ft. The aquifer occupies a trough-like depression in the till surface which slopes and widens from the valley walls toward the Mohawk River. The Schenectady well field is located across the shallow southern end of the trough. The Rotterdam well field is located in the thicker part of the aquifer, between the Schenectady field and the river.

For most purposes the two well fields may be considered as a single center of pumping which was being pumped at an average rate of 18 mgd in 1960-63, approximately 90 percent of which was concentrated in the Schenectady field.

Future development of large ground-water supplies in the eastern part of the county, similar to those of the city of Schenectady and the town of Rotterdam, will be restricted to the coarse sand and gravel deposits that underlie the channel and the flood plain of the Mohawk River between Lock 8, of the New York State Barge Canal, and Hoffmans, because other potential sources of large supplies do not exist in the area. Aquifer tests at the Rotterdam Junction well field and at the prospective well field of the town of Glenville, south of Rectors, indicate that the sand and gravel deposits at each of these places are very permeable and will yield substantial quantities of water.

The chemical quality of ground water used in eastern Schenectady County is satisfactory for most purposes. The water is generally hard and varies over a wide range in the amounts of dissolved mineral constituents. The mineralization of water from bedrock is generally greater than that of water from the unconsolidated deposits, and, in addition, the water from many wells in bedrock is reported to contain objectionable amounts of hydrogen sulfide gas (H_2S). Analyses of water from wells in the unconsolidated deposits show the specific conductance of the waters to range between 147 and 1,080 micromhos, the chloride content to range between 2.1 and 100 ppm (parts per million), the bicarbonate content to range between 71 and 428 ppm, and the total hardness to range between 72 and 508 ppm. The pH of waters from wells in the unconsolidated materials ranged from 7.2 to 8.4.

The concentration of the dissolved constituents in water from stream-infiltration supplies, such as those of the town of Rotterdam and the city of Schenectady, is intermediate between that of river water and ground water. Water pumped at the Schenectady well field had an average hardness of about 150 ppm as compared to a hardness of 230 ppm when the wells were first drilled (1942-43). The average hardness of Mohawk River water ranges seasonally from about 50 to 125 ppm.

DIVISION OF WORK AND ACKNOWLEDGMENTS

The collection and interpretation of most of the data in this report were by, or under the supervision of the authors. Richard A. Wilkens and Robert B. Ryder, Geologists, U.S. Geological Survey, assisted in the tabulation of some of the data for the report or in the preparation of some of the illustrations.

Chemical analyses of water from wells and from the Mohawk River were made by either the U.S. Geological Survey, or by the New York State Department of Health. Data on the flow of streams in the area were collected by the U.S. Geological Survey.

The field work and the preparation of the report were under the supervision of Ralph C. Heath, District Chief, U.S. Geological Survey. The city of Schenectady was represented in the investigation by Malcolm E. Ellis, Mayor, and John F. Kirvin, former Supervisor of the town of Rotterdam. The New York Water Resources Commission was represented by John C. Thompson, Executive Engineer.

J. J. Meehan, former Superintendent, F. R. Bean, Assistant Superintendent, and W. G. Smith, Supervisor of Operations at the well field, all of the Schenectady Department of Water, were very helpful in providing data on the operation of the Schenectady well field, and in cooperating in the collection of hydrologic data in the well field area. Similarly, Wilmer Winfield, former Superintendent of Water and Sewers, and James Wood, former Town Engineer of the town of Rotterdam, were very helpful in providing data on the operation of the Rotterdam well field and in the collection of hydrologic data. Additional information on the hydrology of the area was provided by H. B. Compton, former Town Engineer, town of Glenville; P. L. Reesor, Superintendent of Water and Sewers, town of Niskayuna; and C. W. Gillespie, former Village Engineer, village of Scotia. The interest and encouragement of the Schenectady Water Resources Committee and its chairmen, E. L. Robinson and A. G. Darling, is much appreciated. The authors are indebted to S. S. Selig, Chief Canal Structure Operator, Lock 8, New York State Barge Canal, for his aid in the collection of data on the Mohawk River and of ground-water information in the vicinity of Lock 8. The authors are also grateful to the well drillers in the area, especially Hall and Company, and Stewart Brothers, and to personnel of the Bureau of Soil Mechanics and the Division of Operation and Maintenance, State Department of Public Works, who furnished many of the records of wells and test borings used in the report. W. G. Wilkie, District Sanitary Engineer, New York State Department of Health, furnished many of the analyses of ground water from public water supplies.

The altitudes (feet above mean sea level) which are used in this report were determined and are given in one of two ways, and these are readily distinguishable. Most of the altitudes are approximate only, and were estimated from U.S. Geological Survey topographic maps of the area. These are shown to the nearest whole foot, and are reported in the column headed "altitude above sea level" in the table of well records (table 9). These altitudes were also used in figure 33 and were used in drawing the contours showing the altitude of the bedrock surface in plate 1.

Altitudes were also determined by precise leveling methods in the vicinity of the Schenectady and Rotterdam well fields. Altitudes of this type are given in the report to the nearest hundredth of a foot. These are reported in the column headed "Measuring point - Description," table 9, and are used in several figures and at numerous places in the text. Because these precise altitudes relate only to the area around the well fields, they are based on the city of Schenectady datum at the city pumping station building which is 0.26 feet above the datum of the U.S. Geological Survey. This was done for the convenience of the city.

PREVIOUS REPORTS AND INVESTIGATIONS

The bedrock geology of eastern Schenectady County has been described in publications of the New York State Museum and Science Service by Ruedemann (1930), Goldring (1935), Megathlin (1938), and Fisher and others (1962). The reports of Woodworth (1905), Stoller (1911), Fairchild (1909, 1912), Brigham (1929), and Cook (1924, 1930) pertain to the geology of the glacial and unconsolidated deposits. Simpson (1949) mapped the topography of the buried bedrock surface. Reports by Stoller (Schenectady Chamber of Commerce, 1929), Taylor (1931), and Pirnie and Sawyer (1947) pertain to the hydrology of the aquifer at the city of Schenectady and town of Rotterdam well fields. Simpson (1952) described the ground-water resources of the entire county. Most of the records of wells in Simpson's report are incorporated in the present report and his well numbers, prefixed by Sn, are shown in the remarks column of table 9.

WELL-NUMBERING SYSTEM

The wells cited in this report are numbered on the basis of a geographic grid system. The area of eastern Schenectady County lies approximately between lat 42°45' and 42°58' N. and between long 73°49' and 74°06' W. The area has been divided into quadrangles with a grid of lines of latitude and longitude spaced 1 minute apart. A well is designated by a composite of three numbers: the first indicates latitude; the second, the longitude; and the third, the number assigned to the well in the 1-minute quadrangle. The first digit of latitude and longitude, 4 and 7 respectively, are the same throughout the area and, therefore, are omitted. Thus, in figure 3, well 253-355-1 is the first well on which data were collected in the 1-minute quadrangle north of lat 42°53' N. and west of long 73°55' W. On well-location maps in this report (pls. 1 and 2) the last three digits of latitude and longitude are shown along the edge of the area boundary, and only the number of the well within each quadrangle is shown with the well symbol.

TECHNICAL TERMS

A list of technical terms and abbreviations used in this report is included in the glossary at the end of the report.

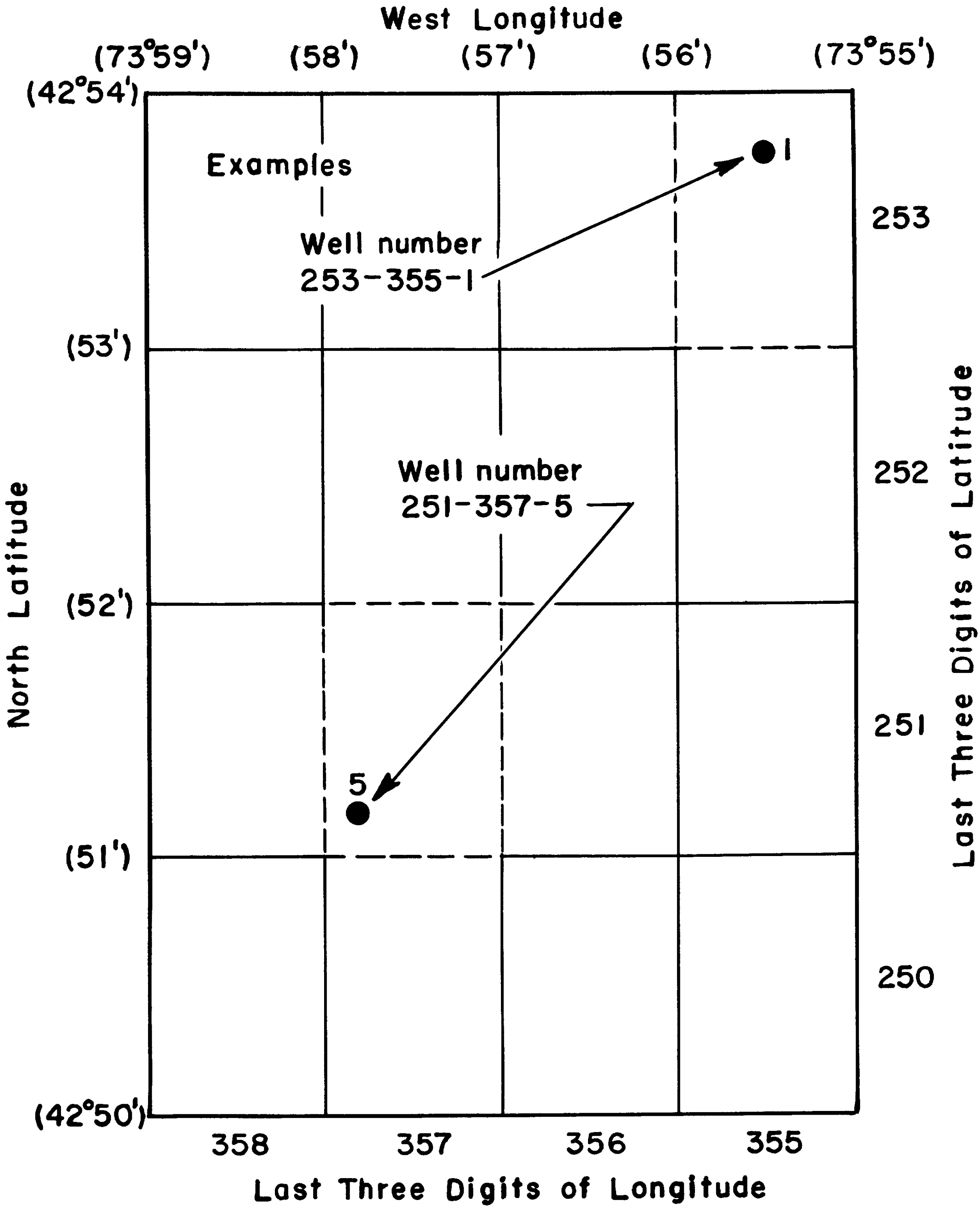

Figure 3.--Well-numbering system.

HYDROGEOLOGY

The occurrence of water both on and beneath the earth's surface is controlled by climate, and affected either directly or indirectly by geology. Thus, hydrogeology - the study of the relationship of geology to the occurrence of water - is an important part of any water-resources study. The geologic deposits in an area, together with associated surface and ground water, may be considered a hydrogeologic system. In eastern Schenectady County ground water is obtained from both bedrock formations and unconsolidated rocks. The availability of ground water in any part of the area depends on the permeability and areal extent of the underlying rocks, their stratigraphic arrangement, and the relative location of ground-water recharge and discharge areas. The topography of the area and the surface drainage reflect the lithologic and erosional characteristics of the rocks. The topography and drainage determines to a large extent the direction of ground-water movement through the rocks from areas of recharge to areas of discharge along streams. For these reasons the topography and drainage are also part of the hydrogeologic system. The hydrogeology of eastern Schenectady County described in this report is restricted to the unconsolidated deposits and to the upper part of the bedrock to the depth normally penetrated by water wells.

The techniques involved in the quantitative evaluation of water occurring on the surface are substantially different from those used in quantitative evaluation of ground-water supplies. We may, therefore, consider a surface system and a subsurface system for quantitative purposes, recognizing that water may pass from one system to the other several times during its movement through an area.

The water resources in eastern Schenectady County are derived from local precipitation except the part of streamflow which is brought into the area by streams that originate in adjacent areas. A large part of the precipitation that reaches the land surface either evaporates, is transpired by plants and returned to the atmosphere, or runs off directly to surface streams. The remainder becomes ground-water recharge which moves downward through the soil zone and the zone of aeration to the zone of saturation. The top of the zone of saturation is called the water table, and its surface is a subdued configuration of the land surface. The water table intersects the land surface at the level of streams and of other bodies of surface water. Water in the zone of saturation slowly moves through the ground under the influence of gravity to areas of discharge. The direction and rate of movement toward areas of discharge such as streams or pumped wells are controlled by the hydraulic gradient and the permeability of the material. Contour lines on maps of the water table are generally more or less parallel to contours of the land surface and, therefore, ground water usually may be considered to move in the general direction of land-surface slope.

Climate determines to some extent the percentage of precipitation that will remain on the land surface to become ground-water recharge and streamflow, and that subsequently can be utilized by man.

SOURCE OF WATER

The climate of eastern Schenectady County is the humid continental type. The winters are cold, but seldom severe. The summers are moderate and prolonged periods of hot weather are unusual. Climatological records have been collected at the Schenectady sewage disposal plant since 1917, and the records for the period 1925-61 are published in the climatological bulletins of the U.S. Weather Bureau (Climatological Data, published monthly, in the Annual Summary, and in the Climatological Summary which is published periodically). The data and terminology that are presented below are from these sources.

The mean annual precipitation at Schenectady is 35.25 inches, and it is rather evenly distributed throughout the year. June is the wettest month and has a mean monthly precipitation of 3.86 inches. February is the driest month and has a mean monthly precipitation of 2.22 inches. The mean, maximum, and minimum monthly precipitation at Schenectady, for the period 1925-61 are shown in figure 4, and the annual precipitation for the same period is shown in figure 5.

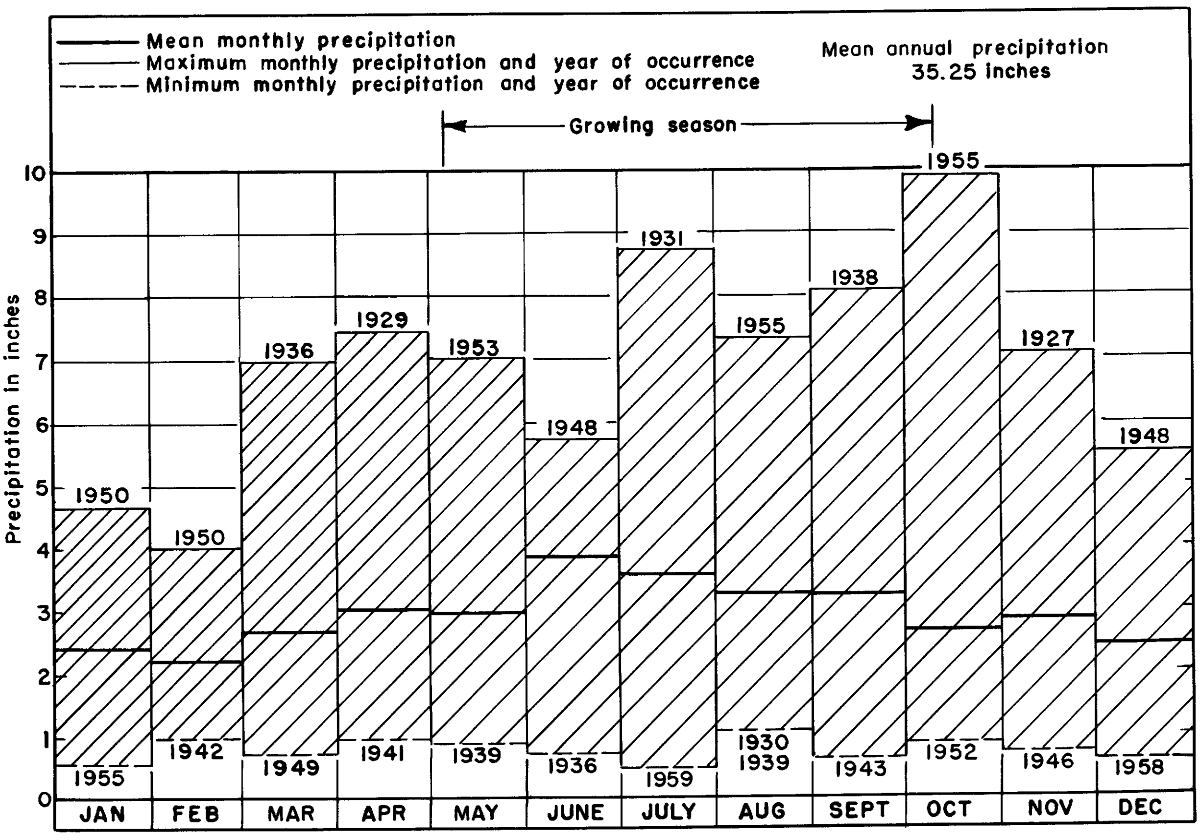

Figure 4.--Mean, maximum, and minimum monthly precipitation at Schenectady (1925-61).

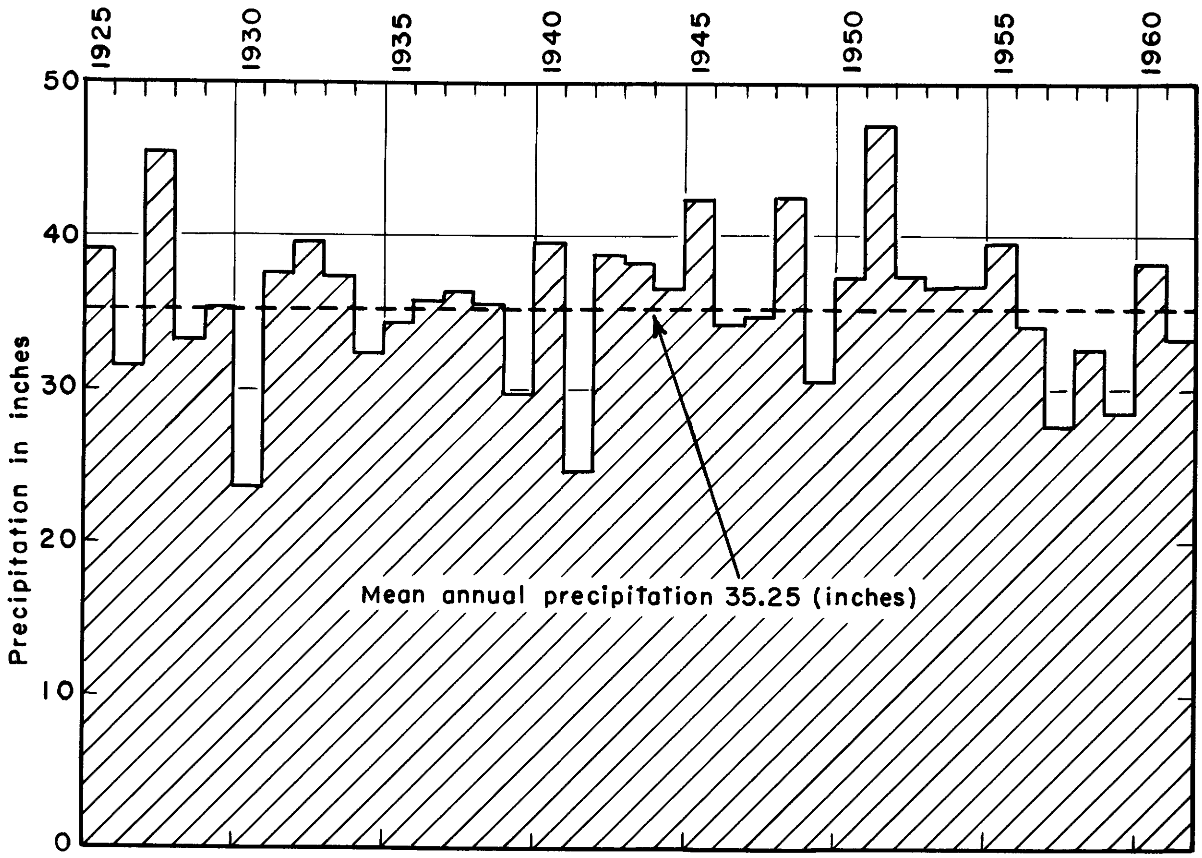

Figure 5.--Annual precipitation at Schenectady (1925-61).

The mean annual temperature at Schenectady is 47.2°F. July is the warmest month with a mean temperature of 72.7°F. January is the coldest month with a mean temperature of 21.5°F. The average date of the first and last killing frosts, which determine the length of the growing season, are October 10 and May 5, respectively (Frederick and others, 1959, p. 11-12). Mean monthly and average maximum and minimum daily temperatures at Schenectady are shown in figure 6.

SURFACE SYSTEM

TOPOGRAPHY

Eastern Schenectady County lies across the western boundary of a lowland that is bounded on the north by the Adirondack Mountains, on the east by the Taconic Mountains, on the south by the Helderberg Escarpment, and on the west by hills that lie between the Helderberg Escarpment and the Adirondack Mountains. The western boundary of the lowland crosses

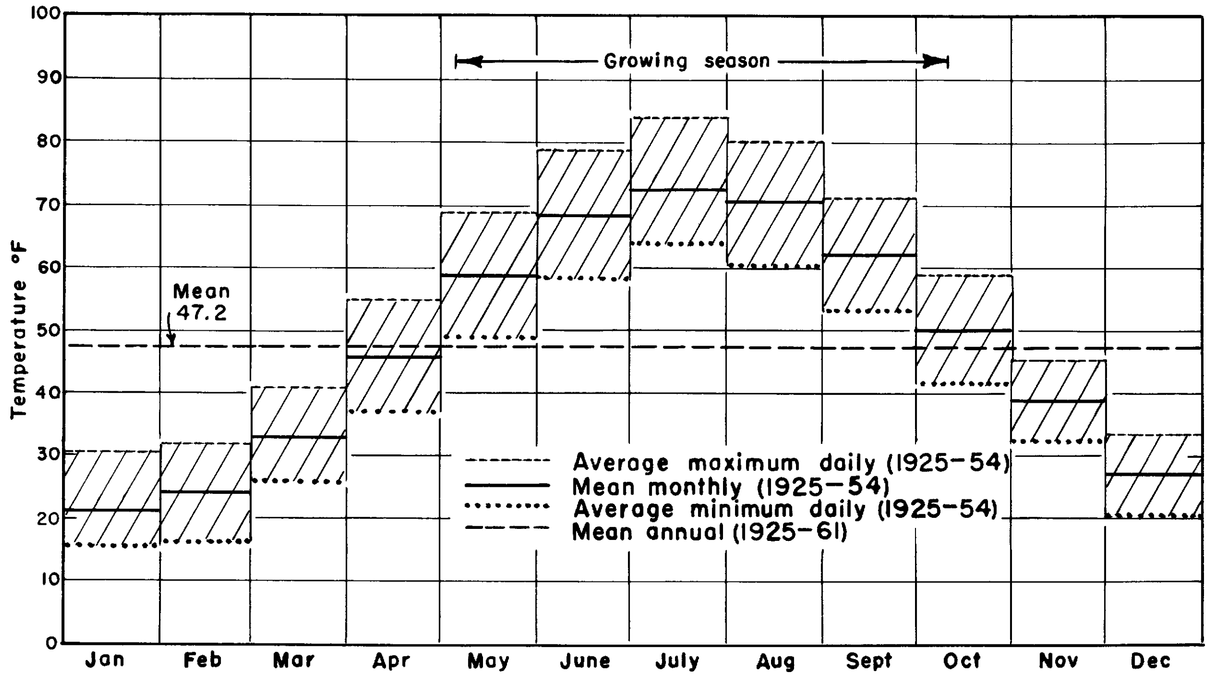

Figure 6.--Mean monthly and average maximum and minimum daily temperatures at Schenectady (1925-61).

the project area in an approximately north-south direction, slightly west of Scotia. The location of this boundary, between the lowland and the hilly area on the west, is indicated in plate 1 by a change in the relative density of the contour lines on the land surface. The Mohawk River flows generally southeastward across the central part of the project area.

The upland in the western part of the area, the adjacent lowland on the east, and the Mohawk River valley are the basic topographic features of eastern Schenectady County.

Upland area

The western parts of the towns of Glenville and Rotterdam consist of till-covered bedrock hills. Glenville Hill and the hills in the town of Rotterdam are part of an upland that ranges in altitude (feet above mean sea level) from about 800 to 1,300 feet. Generally, these hills are smooth and rounded as the result of the scouring action of glacial ice. The positions of more resistant bedrock strata are marked by a series of smoothed benches, or linear ridges. In the areas bordering the Mohawk River the hills are dissected by steep-sided valleys (pl. 1).

The highest of the hills within the project area has a summit altitude of 1,333 feet and is located about 2 miles southwest of Rotterdam Junction (pl. 1). The highest point on Glenville Hill is about 2 miles northeast of Hoffmans (fig. 2 and pl. 1) at an altitude of 1,102 feet. Local relief is greatest along the valley of the Mohawk River, where differences in altitude of more than 900 feet occur within the distance of a mile.

Lowland area

The lowland covers most of the eastern half of the project area, and it is bounded on the west by the upland area. On the east it extends into adjacent Albany and Saratoga Counties. It is divided into two parts by the Mohawk River valley (pl. 1).

Most of the lowland area is a lake plain which has an average altitude of about 350 feet. However, it is not a monotonously level surface. Low and linear till-covered bedrock ridges rise 50 feet above the general level of the plain in some places. The most extensive of these ridges lies approximately along the boundary between the city of Schenectady and the town of Niskayuna. In the small area east of the ridge clayey soils prevail, but, in the remainder of the lowland sandy soils are predominant.

Sand dunes, as much as 50 feet high, occur on the surface of the plain in the southeastern part of the town of Rotterdam and the southern part of the city of Schenectady. Small sand and gravel hills, 20 to 30 feet high, lie along the western boundary of the lowland north of Scotia. Small streams have dissected the surface of the plain, especially in areas adjacent to the Mohawk River valley.

The Mohawk River valley is one of the major topographic features of eastern New York. It divides the project area into two roughly equal northern and southern parts. In the upland area, from Hoffmans to Scotia, the valley is relatively steep sided and about three-fourths of a mile wide. A short distance west of Scotia the valley begins a gradual widening to a maximum width at Schenectady of about 1 1/2 miles. East of Schenectady the valley narrows to Alplaus where it becomes a narrow gorge cut 50 to 100 feet into bedrock.

The altitude of the Mohawk River flood plain is about 250 feet at Hoffmans, 230 feet at Scotia, and 220 feet at Alplaus. Between Alplaus and the Albany County line the area of the flood plain is small, where present, and is at altitudes between 190 and 220 feet.

DRAINAGE

Most of the report area drains to the Mohawk River or its tributaries, the largest of which are Alplaus Kill, Lisha Kill, Plotter Kill, and Poentic Kill (pl. 1). Alplaus Kill drains the northern side of Glenville Hill and a large part of the lake plain northeast of Scotia. Lisha Kill drains parts of the lake plain in the southern part of the project area and adjoining parts of Albany County. Plotter Kill and Poentic Kill drain a large part of the hilly area in the western part of the town of Rotterdam. Normans Kill, a tributary of the Hudson River, drains the lake plain in the southwestern part of the project area. Surface drainage is well developed in the upland area and in the lowland area adjacent to the Mohawk River.

Flow characteristics of small streams

The flow-duration curve of a stream is useful in representing the flow characteristics of the stream. The curves are constructed by plotting the percent of time at which given rates of streamflow are equaled or exceeded. Figure 7 shows the flow-duration curves of four streams in eastern Schenectady County which are representative of streams other than the Mohawk River. The slope of the curve for Plotter Kill is relatively steep and reflects the fact that the area drained by Plotter Kill has relatively steep slopes and consists of till overlying bedrock. Because of the low permeability of both till and bedrock and the steep slope of the land surface, most of the precipitation runs off to streams soon after reaching the land surface. For this reason, streamflow is highest during periods of precipitation and extremely low during periods of fair weather. The curve for the East Branch of Hunger Kill, which drains the sandy soils of the lake plain in adjacent Albany County, is nearly horizontal. The low slope of this curve reflects the fact that most precipitation on the area infiltrates the permeable soil, and that streamflow is sustained principally by a relatively steady rate of ground-water discharge to the stream. Alplaus Kill and Lisha Kill drain areas containing several types of deposits and for this reason the flow-duration curves for these streams are intermediate in slope between the curves for Plotter Kill and the East Branch of Hunger Kill.

Flow characteristics of the Mohawk River

In eastern Schenectady County the Mohawk River is regulated by two navigation dams of the New York State Barge Canal and at a hydroelectric station at Vischer Ferry Dam. (See figure 2.) The average flow of the river at Cohoes, about 10 miles below Lock 7, was 5,647 cfs (cubic feet per second) from a drainage area of 3,456 square miles during the 34-year period of record from 1925 to 1959 (U.S. Geological Survey, 1961). No flow-duration curve is shown for the Mohawk River because the regulation masks the natural flow characteristics. The extent of regulation is so great that any simple statement regarding flow characteristics is misleading unless accompanied by qualifying remarks. For example, the average flow of the river at Cohoes, including the diversion for the barge canal, was 201 cfs (130 mgd) on September 27, 1959, but the three-day average flow for September 26-28, 1959, was 608 cfs (393 mgd). The low flow of September 27 resulted from an increase in storage in one or more of the navigation pools above the gaging station at Cohoes. For the 10-day period September 21-30, 1959, the average flow was 942 cfs (609 mgd).

The lowest 10-day average flow of the river for the period of record was 644 cfs (416 mgd) for the period August 9-18, 1947. The greatest instantaneous discharge ever recorded was 130,000 cfs (84,000 mgd) during the flood of March 19, 1936.

During the navigation season, which usually extends from early April to the early or middle part of December, river levels are regulated by dams at Locks 7, 8, and 9 (fig. 2). During the non-navigation season the dams at Locks 8 and 9 are removed. Ice usually starts to form on the river in

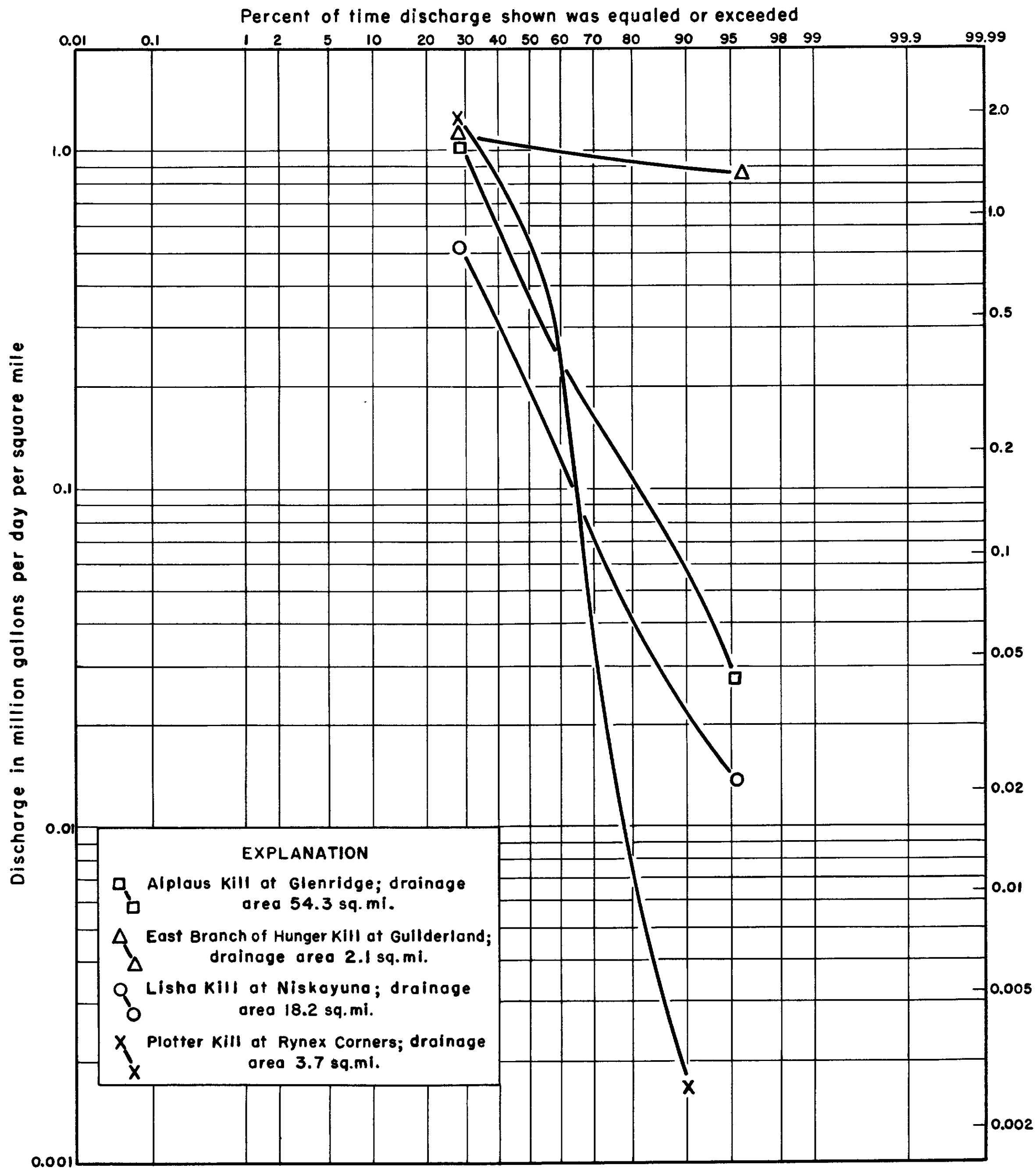

Figure 7.--Flow-duration curves for selected small streams in and near eastern Schenectady County. Curves based on a few measured discharges correlated with the long-term streamflow records of Kayaderosseras Creek near West Milton, Otsquago Creek at Fort Plain, and Poesten Kill near Troy, N. Y.

December in the Lock 8 area, and often reaches a thickness of 3 to 8 inches by the end of the month. During exceptionally long periods of cold weather the ice may reach thicknesses of from 2 to 5 feet in the vicinity of Lock 8 1/. As will be shown later in this report (table 4) in many non-navigation seasons, a temporary thaw occurs and the river ice breaks up. Local flooding may occur as a result of ice-jamming in the channel.

Normal pool levels during the year are as follows:

	Altitude of river level (feet)		
	Lock 7	Lock 8	Lock 9
Navigation season			
Upper pool	212 1/	226	241
Lower pool	183	212 1/	226
Non-navigation season (dams at Lock 8 & 9 removed)			
Upper pool	212 1/	213	225
Lower pool	183	212 1/	216

1/ 212 feet with flashboards installed at Vischer Ferry Dam (Lock 7), 210 feet when flashboards are removed.

Pool levels will be higher or lower than those given above depending upon the flow of the river and power-generation demand. Water use by the hydroelectric plant at Vischer Ferry Dam (fig. 2) usually causes a daily fluctuation of more than a foot in the lower pool level at Lock 8. To facilitate maintenance or repair of lock and dam structures, pool levels during the navigation season are at times held at lower levels than those listed above.

The highest flood stages of the river have been at altitudes of approximately 250 feet above Lock 9; 233 to 235 feet between Locks 8 and 9; 233 feet between Locks 7 and 8; and about 195 feet below Lock 7. The most extensive flooding usually occurs during the navigation season when channel storage is at capacity levels as storm runoff begins. The highest annual discharges usually occur as a result of snowmelt between December 1 and April 15. Ice jams, which occur on the Mohawk River one or more times almost every winter, cause temporary damming and frequently raise river level to flood stage locally.

1/ Mr. S. S. Selig, chief operator, Lock 8, New York State Barge Canal, oral communication, October 15, 1964.

SUBSURFACE SYSTEM

GEOLOGIC SETTING

The geologic units normally penetrated by wells in eastern Schenectady County include shale, limestone, and dolomite of Cambrian and Ordovician age, and the overlying unconsolidated deposits of Pleistocene and Recent age. The bedrock formations generally have low permeability and are poor aquifers. Most of the ground water used in the area is obtained from the more permeable of the unconsolidated deposits. For these reasons, the water-bearing characteristics, thickness, and areal distribution of the unconsolidated deposits received the most attention during this investigation.

BEDROCK

The bedrock in all of eastern Schenectady County consists of interbedded shale and siltstone except in the northwest corner. The northwest corner, west of the Hoffman fault, is underlain by limestone, dolomite, and shale. (See plate 1 and table 1.) The part of the county underlain by shale consists of two distinct areas separated by a fault which passes a short distance west of Vischer Ferry Dam. The larger of the two areas, which includes most of eastern Schenectady County, is underlain by relatively flat-lying beds of shale and interbedded siltstone. The smaller of the two areas lies east of the fault and is underlain by intensely folded thin beds of shale and siltstone.

Water-bearing characteristics

All the bedrock formations are poor sources of water. The rocks are relatively impermeable and water occurs principally in openings along joints in the rock. The yield of a well depends largely on the number of such openings that it intersects. The openings are more numerous in a weathered or fractured zone which generally occurs in the upper few feet of the rock, and many wells in bedrock derive most of their water from this zone. The number and width of joints decreases with depth due to pressure of the overlying rock. Hence, deepening a well in bedrock more than 100 to 200 feet below the rock surface usually does not result in increased yield. The yield of wells in limestone and dolomite formations may be slightly greater than those in shale owing to enlargement of joints by solution. The yield of wells in bedrock is usually adequate for limited domestic requirements. Table 1 summarizes the lithology and water-bearing characteristics of the various formations in the project area.

An example of the water-bearing characteristics of the bedrock is provided by data obtained from well 249-359-25 at Lock 8. The well was drilled through sand and gravel from the surface to 55 feet, through till from 55 to 73 feet, and in shale from 73 to 202 feet. Casing was installed from the land surface to the top of the rock surface. The yield of the

Table 1.--Geologic formations in eastern Schenectady County and their water-bearing characteristics

Class	Age		Geologic formation or unit 1/	Maximum thickness 2/ (feet)	Character of material	Water-bearing properties
Unconsolidated deposits	Quaternary	Recent	Flood-plain deposits	50	Silt and sand, clayey. Contains a few thin beds of sand and gravel. Includes some organic material.	Not important as a source of ground water because of limited thickness in most areas. Dug and shallow drilled wells generally yield sufficient water for domestic needs. In areas where deposits contain a considerable amount of sand and some fine gravel, wells may yield more than 100 gpm.
		Pleistocene	Coarse channel deposits	150	Interbedded sand, sand and gravel, and gravel. Includes a few thin beds of finer-grained material.	Exceptionally permeable materials restricted principally to the Mohawk valley upstream from the Schenectady and Rotterdam well field area. Yields of more than 3,500 gpm may be drawn from properly constructed wells where infiltration from the Mohawk River is possible.
			Lacustrine sand and silt	200	Principally sand and silt. Contains beds of medium- to coarse-grained sand and a few thin, narrow and discontinuous lenses of sand and gravel. Where thick, the lower parts of the deposit contain some beds of clay.	Wells generally yield between 5 and 20 gpm, but wells that penetrate one of the few discontinuous lenses of sand or gravel may yield more than 100 gpm.
			Kame deposits	80	Principally medium-grained sand. Contains beds and lenses of coarse-grained sand and some fine gravel.	Wells generally yield between 20 and 100 gpm. Wells that penetrate one or more layers of the coarse sand and gravel may yield as much as 350 gpm.
			Laminated silt and clay	50	Alternating laminae, or thin beds, of silt and clay. Contains some beds of sand.	Generally yields less than 1 gpm. Most wells in areas of laminated silt and clay are drilled through these deposits into the underlying till or bedrock.
			Till	170	Unsorted mixture of all grain sizes (clay to boulders) deposited by glacial ice. Usually contains thin, narrow, and discontinuous lenses of silt, sand, or sand and gravel.	Generally yields only small amounts of water. The yield of a well in till is largely determined by the number and water-bearing properties of lenses of silt, sand, or sand and gravel that are intersected by the well. The yield of wells in till is usually sufficient for limited domestic requirements except in late summer and fall when some are inadequate.
Bedrock	Ordovician		Schenectady Formation	1,500	Black and gray shale and some beds of dense siltstone and sandstone. Forms the bedrock surface in most of eastern Schenectady County.	Poor source of ground water. Water occurs principally in openings along joints and the yield of a well largely depends upon the number of joints that are intersected by the well. Inasmuch as the rock itself is relatively impermeable, and the number and width of joints decreases with depth, deepening a well in bedrock more than 100 to 200 feet below the rock surface usually does not result in increased yield. The yield of wells in limestone or dolomite may be slightly greater than those in shale owing to enlargement of joint openings by solution of the rock. The yield of wells in bedrock is usually adequate for limited domestic requirements. Water from bedrock may contain objectionable amounts of hydrogen sulfide gas (H_2S) or dissolved mineral constituents.
			Snake Hill Formation	600-800	Dark gray silty shale, intensely folded. Forms the bedrock surface east of a north-south trending fault approximately through Lock 7. (See plate 1.)	
			Canajoharie Shale	400-500	Black shale, carbonaceous and more or less calcareous. Form rock surface west of Hoffmans Fault	
			Undifferentiated limestone and dolomite units of the Trenton and Black River Groups	45-55	Limestone and dolomite. Form rock surface west of Hoffmans Fault	
			Tribes Hill Limestone	175-200	Limestone and dolomite. Form rock surface west of Hoffmans Fault	
	Cambrian		Little Falls Dolomite	400	Dolomite. Form rock surface west of Hoffmans Fault	

1/ Names of the bedrock units conform with usage of the U. S. Geological Survey. It also conforms with the nomenclature used on the geologic map of New York (Fisher and others, 1962).

2/ Thicknesses of bedrock units in eastern Schenectady County were provided by D. W. Fisher, State Paleontologist, New York State Museum and Science Service (oral communication, 1962).

well during a 24-hour pumping test, conducted by the driller, was 4.6 gpm with a drawdown of 170 feet. The transmissibility and permeability of the shale, as estimated from the test data, are about 50 gpd per foot and 0.4 gpd per square foot, respectively. Despite the low permeability of the shale, the yield of this well would easily meet most domestic needs. The drawdown of the water level in wells in bedrock is generally great, and the water level usually does not return to static level for many hours after pumping stops. For example, an hour after the end of the pumping test, the water level was still 75 feet below the static level at the beginning of the test.

Bedrock surface

The configuration of the bedrock surface is shown by the heavy contours in plate 1. It may be observed that there is a marked similarity in the configuration of the bedrock surface and the present land surface. There are, however, a few significant differences.

The most notable differences exist in the south-central part of the area where deep troughs underlie part of the lowland south of the Mohawk River. In this area the presence of the troughs is not evident at the land surface because they have been filled by unconsolidated deposits. The troughs in the bedrock surface represent the valleys of a preglacial drainage system that was first mapped by Simpson (1949, fig. 1).

The deeper, and westernmost, trough south of Schenectady was probably the course of the preglacial Mohawk River. The shallower trough probably represents the valley of a stream tributary to the preglacial Mohawk. The contours showing the juncture of the preglacial valleys represent a significant departure from Simpson's map because they are based on data not available in 1949. Similar data obtained in this investigation permits the extension of the tributary valley north of Alplaus, as shown in plate 1. These valleys probably were broadened and deepened to some extent by the scouring action of glacial ice as one or more of the Pleistocene ice sheets advanced into and over the area. Plate 1 indicates that the unconsolidated deposits now filling the southern part of these troughs are as much as 350 feet thick.

The scouring action of the ice is also responsible for other features of the bedrock surface. These are the linear ridges and depressions, the alignment of which indicates the local direction of ice movement. Many of these features are less than 100 feet high, or deep, and therefore, are not indicated by the bedrock contours in plate 1. The lineation, however, is reflected in the topographic contours. These linear features indicate that the local direction of ice movement in the project area was west-southwest along the broad ice-scoured valley north of Glenville Hill. The direction of movement was southwest over the hills in the western part of the town of Rotterdam, and was south-southwest over the remainder of eastern Schenectady County.

As the irregular front of the ice sheet advanced over the area, minor tongues extended in front of the main ice mass. These ice tongues moved through lowland areas in directions that were controlled by local topography. It is possible that a small tongue of ice moved northwestward from Scotia a short distance up the Mohawk valley during an early phase of the last glaciation of this area.

DEPOSITION OF THE UNCONSOLIDATED DEPOSITS

Almost all of the unconsolidated deposits in eastern Schenectady County are the result of glaciation. These rocks consist of: glacial till that was deposited directly by the ice; sands, silts, and clays that were deposited in the waters of temporary glacial lakes; and coarse sand and gravel that was deposited by streams originating at the melting ice front. Sand and silt has been deposited on the flood plains of the present streams. The areal distribution of the unconsolidated surficial deposits is shown in plate 1, and a brief description of their lithology and water-bearing characteristics is contained in table 1.

During the Pleistocene Epoch ice advanced southward from Canada into the northern United States at least four times. The last of the four major ice sheets (and possibly some of the earlier ones) advanced over the Schenectady area from the north. As the ice advanced southward, principal movement was around the Adirondack Mountains and across pre-existing lowlands. One lobe of the ice moved south along the Champlain-Hudson lowland, and another around the western side of the Adirondacks. South of the Adirondack Mountains, the ice fanned out in its direction of movement. The lobe west of the Adirondacks moved into the area north of Utica and Rome that is now drained by the Mohawk River. The lobe of ice moving south along the Champlain-Hudson lowland spread out into the lower Mohawk valley from the northeast. Part of this lobe advanced westward up the Mohawk valley and across the upland area between the Adirondack Mountains and the Catskill Mountains (on the south) and out of the project area.

As the ice advanced into and over the Schenectady area, the topography was modified by ice scour and the deposition of till. Valleys aligned with the direction of ice movement probably were deepened and broadened by ice scour, whereas valleys lying across the direction of ice movement were less subject to scour. As the ice became thicker it overrode the uplands, smoothing the surface by the action of ice scour. The thickness of the ice over the Schenectady area probably was several thousand feet at the time of the maximum advance of the last ice front. The till deposited by the ice is thinnest in the upland areas, and thickest in the depressions in the rock surface.

During the retreat of the ice from the project area, the lowlands were covered by a large lake which was impounded between the highlands to the south and the ice that had not yet melted out of the Hudson lowland. This glacial lake was called Lake Albany by Woodworth (1905, p. 175).

Data are lacking as to the full extent of Lake Albany but Woodworth believed that it occupied all of the lowland and that it was impounded by ice or glacial deposits in the Hudson valley, about 100 miles south of the project area. Obviously it was a large lake and the materials deposited in it are now found in all parts of the project area below an altitude of between 350 and 400 feet, including the present Mohawk River valley west of Scotia. East of Scotia the valley contains both Lake Albany deposits and flood-plain deposits laid down by the river in Recent time. Most of the deposits of sand, silt, and clay in the area, except the uppermost deposits on the flood plain of present streams, were laid down in Lake Albany.

A large part of the Lake Albany sediments, mostly sand, silt and clay, but including some gravel, were transported down the Mohawk River valley by melt water from the ice lying west of the project area. The current was swift enough in the part of the lake occupying the Mohawk valley west of Scotia so that the deposits there were restricted to coarse sand and gravel. Immediately west of Scotia, the Mohawk valley broadens, and as a result the current slowed substantially, and was unable to transport the coarse-grained materials. The deposits below this point are much finer grained. In the deeper parts of the lake, where the currents were very slow, laminated silt and clay was deposited.

Eventually the level of Lake Albany declined as the drainage outlet of the lake eroded its channel through the barrier in the lower Hudson valley. As the lake ceased to exist in the Schenectady area, the Mohawk River began to re-excavate its valley upstream from Scotia, and to erode its present course downstream from Scotia. The river has eroded its present channel in the fine-grained Lake Albany deposits from Scotia to Aqueduct. From Aqueduct to the Albany County line, the river has cut a new (postglacial) channel in bedrock. Stoller (1911, p. 41) believed that the river followed several different courses downstream from Scotia before the present course was established.

The brief discussion of the glacial history of the area presented in the preceding paragraphs is much simplified, and it provides only a general description of the events in the project area during Pleistocene time. This description does not fully explain the abrupt gradation of the coarse sand and gravel deposit in the Mohawk valley west of Scotia into the fine-grained deposits south of Scotia. (See plate 1 and figure 8.) Such an abrupt termination of the sand and gravel deposit is unusual. In the vicinity of the Schenectady and Rotterdam well fields the coarse sand and gravel deposits lie upstream of a till ridge and the finer grained sand and silt lie downstream. (See plates 2 and 3, and figure 8.) The coarse sand and gravel may have been trapped behind the till ridge. However, the available data are inadequate to establish the extent of this ridge and it is possible that it does not extend across the entire valley.

Another, and more plausible, reason for the sudden decrease in grain size is that the river valley widens quite rapidly at Scotia. Thus, river currents entering the wider reach would immediately lose velocity and the competence to transport the coarse gravel further. If the coarse sand and gravel deposits once extended into the area south of Scotia, they have since been destroyed.

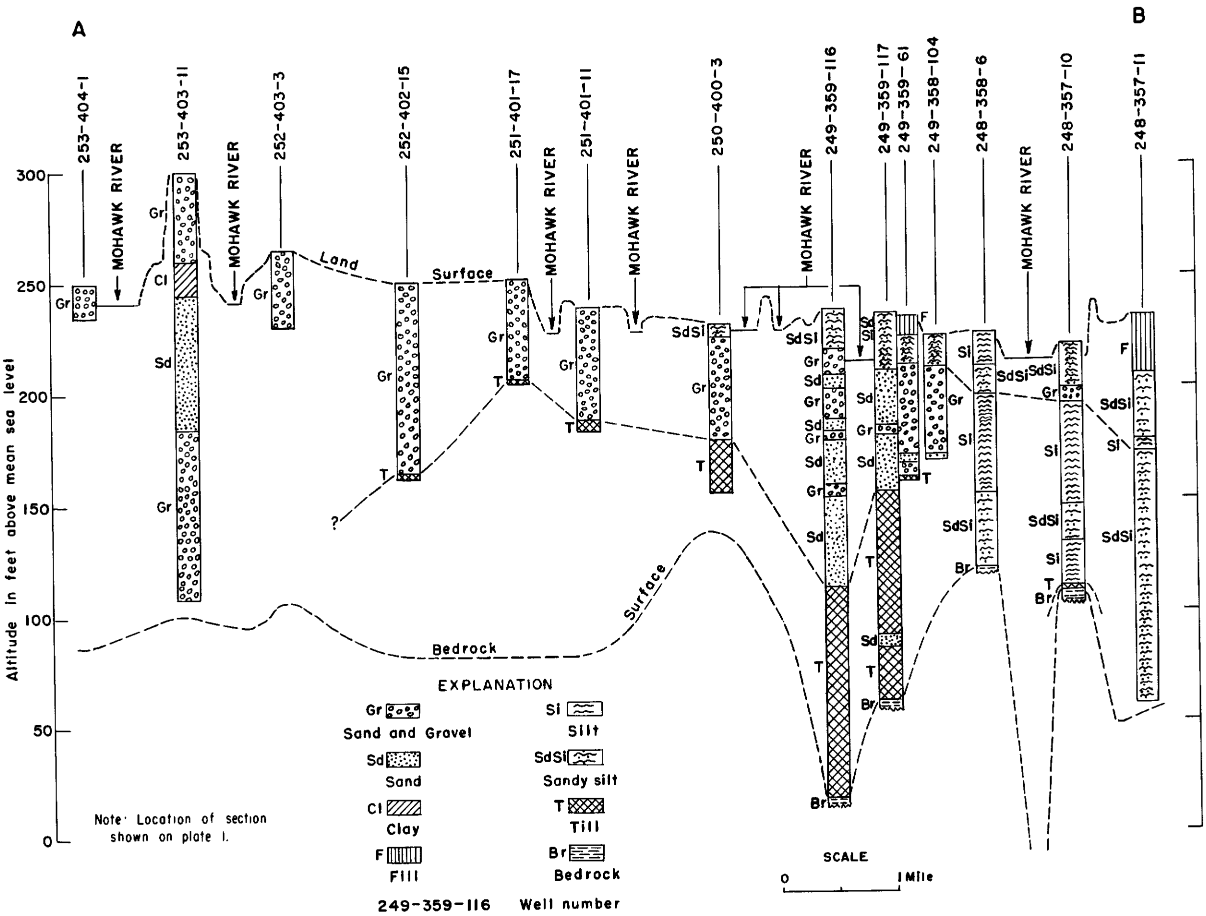

Figure 8.--Geologic section along the Mohawk River flood plain from near Hoffmans to Schenectady.

The unconsolidated deposits in the area are not of uniform character, but consist of interbedded strata or lenses of different types of materials. Major types of deposits, which are locally predominant and areally extensive, are discussed in the following paragraphs.

TILL

Till is a heterogeneous mixture of rock particles of all grain sizes which was deposited directly by glacial ice. The unweathered till in this area is generally a gray to dark gray, dense, tough, stoney, silty and sandy clay, which contains some cobbles, and even large boulders. The weathered till is brown, due to the oxidation of iron. Lenses of sand, or sand and gravel are scattered through the deposit in a sparse and random manner. These lenses were incorporated into the till during its deposition. They range in areal extent from less than a square foot to possibly several hundred square feet, and in thickness from a fraction of an inch to several feet.

Till mantles the bedrock surface over most of eastern Schenectady County. (See plate 1.) It is the predominant surficial material on the bedrock hills in the western part of the area and on the low ridge that lies along the boundary between the city of Schenectady and the town of Niskayuna. Till also mantles the bedrock ridges that project above the sand plain northeast of Scotia, in the town of Glenville. On the higher hills and upland slopes the till cover generally ranges from 10 to 30 feet in thickness. In the troughs in the bedrock surface, the till may be more than 200 feet thick (it is at least 204 feet thick in well 251-401-8), and in such areas it is generally overlain by other deposits.

Water-bearing characteristics

In eastern Schenectady County, till that does not contain lenses of silt or sand is essentially impermeable. E. S. Simpson (unpublished data in the files of the U.S. Geological Survey) tested the permeability of many samples of till from the Schenectady area and found the field coefficient of permeability to range from 0.004 to 0.001 gpd (gallons per day) per square foot. In contrast, a well-sorted sand may have a coefficient of permeability of several hundred gpd per square foot. The low permeability of till is due to the lack of sorting of different sized grains. In a well-sorted sand, water can move relatively freely between the grains, but in a till these spaces are filled with fine particles, the spaces between which are in turn filled with finer particles. Therefore, the empty spaces in a till are very small and water moves through them with difficulty.

The effective permeability of till is due to the lenses and partings of silt, sand, or gravel that are scattered through the deposit. The yield of a well in till is largely determined by the number and water-bearing properties of the more permeable lenses that are intersected by the well. If no permeable lenses are penetrated, a well in till will be essentially dry. If permeable lenses are penetrated the yield of the well will be determined by the areal extent of the lenses and the rate at which water will enter the lens from the enclosing till. In other words, these lenses serve to collect water which moves very slowly through the till, and to conduct it to the well. If few permeable lenses are intersected, and if the areal extent of these is small, the yield of the well will be small. If the permeable lenses are sufficiently thick and areally extensive, then the yield of the well will be larger.

At many places a thin relatively permeable zone exists between the base of the till and the bedrock surface. The material in this zone is usually described in the logs of wells as gravel, and where found it is usually a foot to several feet thick. The material in this zone may be of several different origins. It may be water-laid material that was deposited before deposition of the till. It may be part of the soil zone that existed on the bedrock surface before the ice advance, and which was partially incorporated in the base of the till sheet deposited by the overriding ice. It may also consist of fragments which were eroded from the bedrock surface and which were in the process of being incorporated into the till at the time glacial erosion of the rock surface came to a

halt. In cases where such a permeable zone is penetrated by a well and is the source of water to the well, it is classified with the till deposit, even though the water-bearing zone may be described as silt, sand, or gravel.

The method of well construction is an important factor in determining the yield of a well in a till deposit. If a well in a till deposit is lined with uncemented stone or porous tile, water can enter the well from all of the intersected silt, sand, and gravel lenses. However, if the lining used is impermeable (watertight) only the water-bearing zone at the bottom of the lining (casing) can yield water directly to the well.

The diameter of a well in till is also a factor which may determine the adequacy of the well for a given purpose. A large-diameter well contains a relatively large amount of water in storage per foot of water depth as compared with a small-diameter well. The volume of water is about 53 gallons per foot in a 36-inch-diameter well and about 24 gallons per foot in a 24-inch-diameter well. The volume of water is only about 1 1/2 gallons per foot in the 6-inch-diameter steel casing which is normally used in domestic wells drawing from bedrock.

The pumps normally used in domestic wells have a capacity of several gallons per minute. Thus, if the yield of a well is only a fraction of a gallon per minute (as it is for many wells in till), water drawn from the well will be largely from storage within the well during the period of pump operation. Obviously, the pump could operate for only a few minutes in a small-diameter well before the water level in the well would be drawn down to the pump-intake level. A much longer period of operation of a similar pump is possible in a large-diameter well for the same amount of drawdown in the well.

An example of the water-bearing characteristics of the permeable layer at the base of the till is given by the water-supply wells at the West Hill housing development in the town of Rotterdam. The supply is from four wells, 248-400-4, -5, and -6, and 249-400-3, which were drilled through till to the bedrock surface (pl. 1). Each of the wells is more than 100 feet deep and each has penetrated a permeable zone at and just above the bedrock surface. The permeable zone consists of a few feet of gravel at the bottom of the till. The weathered and fractured zone at the top of the bedrock (mentioned earlier in the description of the water-bearing characteristics of bedrock) probably also contributes water to the wells. Steel casing extends to the gravel zone in three of the wells and to the weathered shale in well 248-400-6. In constructing the wells, no permeable zone in the till was recognized by the drillers other than at the base of the till. The first two wells (248-400-4 and 249-400-3), drilled in 1948 and 1949, were reported to have initial yields of about 30 gpm each. In 1962 the yield of each well was about 10 gpm. The decrease in yield with time is possibly due to progressive clogging of the wells. Two additional wells (248-400-5 and -6), were drilled in 1960, and each is reported to yield about 20 gpm when drilled. However, these two wells are close together and their long-term combined pumping rate is probably less than 40 gpm because of mutual interference. The average combined pumping rate from the entire system in 1961 was about 12 gpm.

The yield of the wells described above is higher than that of most wells in till because they penetrate a relatively widespread permeable zone at and above the top of the bedrock. Only a few wells, for which data are available, are known to penetrate only till, and these yield less than 1 gpm. Wells 250-353-5 and 251-401-13, both 6-inch-diameter steel-cased wells, 45 to 46 feet deep, had yields of 1/3 and 1/2 gpm, respectively. Both were considered inadequate for domestic use, probably because of the small storage capacity of the well. Well 252-401-3 is a dug well 5 feet deep lined with 24-inch tile. The well is believed to have penetrated a small gravel lens in the till. The yield is reported to be about 1/10 gpm and is adequate for limited domestic use because of the storage capacity in the well. Well 253-402-2 is a dug well, 25 feet deep, lined with open stone. The yield of the well is reported to be between 1/4 and 1/2 gpm.

LAKE SILTS AND CLAYS

Thin alternating beds of silt and clay were deposited in the quiet waters of temporary glacial lakes in eastern Schenectady County. Most of these deposits were laid down in glacial Lake Albany (Woodworth, 1905). The individual layers of these deposits are relatively uniform in thickness but differ from one another in thickness and composition. The finer grained layers generally range from a fraction of an inch to several inches in thickness. The material in them ranges from nearly solid clay to clayey silt that contains some fine sand. The thickness of the coarser grained layers is generally about an inch except for a few layers as much as a foot thick. The coarse-grained layers are predominantly silt with some fine sand, but the thicker of the coarse-grained layers usually contain mostly fine sand. In some places the deposition of the thin-bedded deposits was interrupted temporarily by the deposition of even thicker beds of sand. The thickness of these sand beds reaches 5 feet or more. The lateral extent of such beds could not be determined but is probably a few hundred feet or less.

The largest area in which the silts and clays are near or at the surface is in the eastern part of the town of Niskayuna where they occur at altitudes of up to about 350 feet (pl. 1). Other smaller areas in which thin-bedded silt and clay are at the surface are: (1) in the Normans Kill valley in the southern part of the town of Rotterdam, below an altitude of about 300 feet; and (2) in the valley about 1 1/2 miles northwest of Alplaus. Deposits of thin-bedded silt and clay occur in the vicinity of High Mills, at altitudes up to about 400 feet where they were deposited in a small temporary glacial lake, Lake Alplaus (Stoller, 1911, p. 26). Excavations made in the city of Schenectady, principally the northeastern part, have exposed thin-bedded silt and clay at shallow depths beneath the soil.

The thickness of deposits of thin-bedded silt, sand, and clay is not easy to determine. The surface exposures are generally poor, and partially slumped, and one rarely sees more than a 5- to 10-foot section of the thin-bedded deposits at any one place. Along the valley west of Lock 7, the aggregate thickness of these deposits appears to be nearly 50 feet, however,

parts of the section are covered and there is an indication of some sand lenses, or beds, within the deposit. In well 248-351-9, located near the head of the valley, 30 feet of clay is reported to overlie bedrock. In the Lisha Kill valley, about a mile south of Lock 7, about 5 feet of thin-bedded clay, silt, and sand are exposed in a slope about 10 feet above a small sand pit in which about 5 feet of fine sand is exposed. The sand is believed to be a lens or bed within the thin-bedded deposit, but part of the section is covered and the relationship is not clear.

The area in which thin-bedded deposits occur at the surface is small in comparison with the area in which these deposits are overlain by lake sand. Clay is reported by well drillers to underlie 10 to 30 feet of lake sand in the area extending northward along the western side of the Alplaus valley from near the Mohawk River into the level area west of High Mills. These deposits may be either lake silts and clays or till, or both in part. Silts and clays also underlie the surficial sands south of the Mohawk River at altitudes ranging from 100 feet in the deeper parts of the bedrock surface to 320 feet in areas where bedrock is nearer to the land surface. They were deposited in Lake Albany as a blanket over the till-covered bedrock surface. Thickness of these buried silts and clays ranges from 20 to 150 feet. The drilling characteristics of the silt and clay deposits and of the till are sufficiently similar so that the distinction between the two is difficult to make. The thin-bedded silt and clay deposits usually contain sufficient sand and concretions (along silt layers) so that, to the driller, the material has the clayey, silty, sandy and pebbly aspect of till. The water-yielding characteristics of both types of deposits are similarly poor, and the need for a driller to distinguish the difference between them is not great. For these reasons the drillers' logs shown in figure 33, and used extensively in this report, are subject to interpretation.

Water-bearing characteristics

The clay layers of the thin-bedded deposits are relatively impermeable as compared to the silt and sand layers. For this reason the water-bearing characteristics of these deposits are largely dependent on the character and thickness of the clay layers. Regardless of the high permeability of the coarser silt and sand layers, the rate at which water can move into them from above is controlled by the low permeability of the clay layers. Ground water enters the deposits from above, percolates downward to the water table and then moves downward and laterally under the influence of the hydraulic gradient. The loss of head in moving water downward across the clay layers is very great and, thus, the amount of water entering the deposit is small. As a consequence, the yield of wells in these deposits is also small. In fact, most wells in areas in which thin-bedded silt and clay occur obtain water from overlying deposits of sand, sand lenses or beds within the deposits; or the wells are drilled through the silt and clay and obtain water from the underlying till or bedrock.

The discussion of the construction and yield of wells in till is also generally applicable to wells in deposits of thin-bedded silt and clay. The water entering a well moves through the coarser grained layers. The

amount of water that will move through the layers of silt to the well is less than that which will move through the more permeable sand. These coarser layers serve to collect water that moves vertically through the less permeable clay layers, and to conduct it to the well.

The water supply for the Willow Brook Park housing development in the town of Glenville (Water District 4) is developed in an area of alternating coarse- and fine-grained deposits. A composite generalized section in the immediate area, from the land surface downward, is as follows:

Bed	Material	Approximate thickness (feet)
A	Surficial sand	20
B	Thin-bedded silt and clay	10
C	Sand	10
D	Thin-bedded silt and clay	10
E	Sand	3
F	Till	15
G	Bedrock	

The water supply is obtained from two gravel-filled excavations in the bottom of valleys eroded into the section. The excavations are at the site of former springs. Water is pumped from perforated collector pipes buried in the gravel fill.

The higher of the two excavations (one well number, 252-355-10, pl. 1) is located in the floor of a small gully in the valley wall of a tributary to Alplaus Kill, and was apparently excavated in bed B and possibly bed C. The original spring probably existed at the contact of beds A and B. It is reported, however, that water is obtained from the thin-bedded deposits of bed B. The lower excavation is located a few feet away in the floor of the tributary and has concrete walls. The original spring reportedly issued from the valley floor, near creek level, apparently from bed E. Part of the flow of the creek has been diverted and flows across the gravel fill to supplement the supply through infiltration into the gravel.

The combined pumping rate from both wells is estimated to be between 35 and 50 gpm. The average use is reported to have been 23,000 gpd (about 16 gpm) in 1961. The relative amounts of water derived from ground-water sources and from the stream by infiltration is not known.

Well 254-355-5 is a dug well lined with a 24-inch-diameter tile. The tile was installed at a spring on the slope of Alplaus Kill valley. Silt and clay were observed in the slope immediately above the well and occur in the slope below the well. About 1 gpm flows from an overflow pipe in the side of the tile. Water is believed to enter the well from a sand layer in the thin-bedded deposits.

Well 254-355-4 is a 6-inch steel-cased well, 65 feet deep. The well is reported to have penetrated blue clay between the depths of 25 and 65

feet except for a gravel lens that occurred between 43 and 45 feet. The casing was perforated opposite the gravel lens. The well is reported to yield 3 gpm.

LAKE SANDS

Most of the surficial deposits in the southern part of the town of Rotterdam and the city of Schenectady, and in the eastern part of the town of Glenville, are sands that were deposited in Lake Albany. (See plate 1.) The sands are medium to coarse grained in the higher parts of the deposits and are generally medium to fine grained in the lower part. The sands are predominantly silty, but tend to be better sorted in the upper part of the section. Locally the sands contain thin discontinuous lenses of coarse sand and gravel. The thickness of the sand ranges from a few feet to nearly 250 feet, and it occurs at the surface at altitudes ranging from about 240 feet to slightly above 350 feet.

The lake sands south of the Mohawk River (pl. 1) are underlain by fine-grained lake deposits within that part of the area generally below the 200-foot contour on the bedrock surface. In figure 33 these fine-grained deposits are identified as silt or clay. In the area approximately defined by the bedrock contours at 200 feet and above, in plate 1, the lake sands are underlain by till. The greatest reported thicknesses of lake sand are in wells 247-359-1 and -2, 243 and 193 feet, respectively. (See plate 1 and figure 33.)

The lake sands north of the Mohawk River are generally underlain by till or bedrock (pl. 1). In that area the reported thickness of the sand is generally less than 45 feet, however, the sand reaches thicknesses of 55 to 130 feet in wells 252-354-8 through -11 near Glenridge. (See plate 1 and figure 33.)

Lake sands were also deposited in the Mohawk River valley west of Scotia when it was an inlet of glacial Lake Albany. Most of these deposits have been removed by erosion since the lake ceased to exist, but remnants of them are found in terraces along the valley walls up to altitudes slightly above 350 feet. These sands are similar to the lake sands in the lowland areas, but because the lake currents were somewhat stronger in the restricted width of the valley during their deposition, beds of medium- to coarse-grained sand are more common.

A small area of thin sand and silty sand occurs in the valley of Crabb Kill north of Glenville Hill (pl. 1). These deposits were laid down in a small lake impounded in the valley during the retreat of the last ice sheet. The deposit is similar in character and is continuous with the lake sands in the lowland northwest of Alplaus.

Water-bearing characteristics

The lake sands are relatively much more permeable than either thin-bedded silt and clay or till because the sands are coarser grained. The

lower part of the lake sand section is composed of silt and fine sand, and the coefficient of permeability may range from 20 to 100 gpd per square foot. In the upper part of the lake sands, which are composed of medium- to coarse-grained sand, the permeability may be as high as 1,000 gpd per square foot.

Many domestic wells, and the wells of some small public supplies, obtain water from lake sands in the area north of Scotia. Most of the domestic wells are driven wells with screened drive points, but many are drilled or dug wells. The yield of these wells is generally between 5 and 20 gpm, but properly developed wells may yield much more.

The Rotterdam and Schenectady public water supply systems serve most of the area south of Schenectady. For this reason very little information is available from wells in that part of the project area except from a few industrial wells and test holes.

Examples of the water-bearing characteristics of the lake sands are provided by the yield of supply wells of two small public water supply systems. The supply wells for one of these systems, the Forrest Hills-Mayfair housing development, are on the lowland in the town of Glenville, northeast of Scotia. The second is at Fort Hunter, in Albany County, about a mile south of the point where the New York State Thruway crosses the Albany-Schenectady County line. (See plate 1.)

The water supply for the Forrest Hills-Mayfair housing development (Glenville Water District 5) is from six wells. Four of the wells (252-356-8, -9, -10, and -11) are about 25 feet deep and have yields ranging from 10 to 20 gpm each. These wells are drilled into bedrock and are screened and gravel packed in the weathered and fractured zone at the top of the bedrock surface, but it is believed that most of the water entering the wells comes from the sand, rather than from the bedrock. The purpose of screening and gravel packing the wells below the base of the sand was to increase the available drawdown. The other two wells are believed to be similar in construction, but are buried and no data are available from them. The average maximum combined pumping rate from all six wells has been about 30,000 gpd, or slightly more than 20 gpm.

At Fort Hunter, Albany County, the public supply well penetrated about 30 feet of coarse sand which overlies sandy clay. The field coefficients of transmissibility and permeability of the coarse sand, as calculated from a pumping test conducted by the driller (Hall and Company), is about 25,000 gpd per foot and 1,000 gpd per square foot, respectively. The well could have been pumped at a rate of about 300 gpm for a few days, but the long-term safe yield of the well is estimated to be between 80 and 100 gpm.

A pumping test was conducted at the New York State Campus site in the western part of the city of Albany, Albany County, by the driller (Stewart Brothers Water Wells Company) and the Geological Survey. The permeability of the lake sands at this site was found to be 350 gpd per square foot. Pumping tests at Saratoga National Historical Park, Saratoga County, (Heath and others, 1963, p. 114) showed the field coefficient of permeability of the lake sands there to be about 700 gpd per square foot.

KAME DEPOSITS

Small groups of low elliptical-shaped hills occur in the area northwest of the Schenectady County Airport (pl. 1). These hills are referred to as kames and were formed by streams that drained directly from the ice front. They mark the position of part of the ice front during a brief pause in the retreat of the last ice sheet. The kames are partially buried by lake sands and silts, but they differ lithologically from the lake deposits in that they consist principally of medium-grained sand and contain beds of coarse-grained sand and some fine gravel. They contain only minor amounts of silt and clay. These coarser grained deposits underlie the lake sands and silts from the area of the kames south to the Mohawk valley.

A smaller group of kames, probably deposited at the same time as those described above, lies in the valley north of Glenville Hill. These kames, which lie to the west and to the northeast of the village of Glenville (pl. 1), contain medium- to coarse-grained sand along with a small amount of gravel.

Water-bearing characteristics

The permeability of the kame deposits is greater than that of the lake sands because the average grain size of the material is coarser. Wells in these deposits generally yield between 20 and 100 gpm, and some wells that penetrate one or more of the coarse sand and gravel lenses in the deposit yield as much as 350 gpm.

Two small public water supply systems, and a test well of the town of Glenville furnish examples of the water-bearing characteristics of the kame deposits.

The water supply for the Indian Hills housing development (Glenville Water District 9) is from two wells (250-356-15 and 251-356-12) drilled through coarse sand, containing some fine gravel, to the bedrock surface 34 and 35 feet below the land surface, respectively. (See plate 1.) Both wells have screens about 5 feet long placed just above the bedrock surface. During pumping tests conducted on the wells by the driller (Stewart Brothers Water Wells Company) well 251-356-12 yielded 80 gpm with a drawdown of less than 6 feet and well 250-356-15 yielded 76 gpm with a drawdown of less than 5 feet. The transmissibility and the field coefficients of permeability of the aquifer are estimated to be about 23,000 gpd per foot and 1,400 gpd per square foot, respectively. The aquifer is relatively thin and a shale ridge west of the wells constitutes a barrier to ground-water flow to the wells from that direction. Although detailed data are not available it is possible that the maximum yield of this water supply is more than 50,000 gpd.

The water supply for the Willow Glen housing development (proposed Glenville Water District 10) is from a group of six driven wells which are designated as one well, 251-357-7. The wells are about 30 feet deep and equipped with drive-point screens 3 feet long. The total thickness of the aquifer is reported to be more than 36 feet. A shale ridge west of the

well fields acts as a barrier to ground-water flow to the wells from that direction. The group of wells had a combined yield of 70 gpm during a 4-hour pumping test conducted by the driller (W. Socha). The drawdown of the water table in the aquifer was 15 feet in an observation well in the center of the well field, hence, the drawdown in the pumped wells was more than 15 feet. Because of this, and because the aquifer is very thin and the recharge area is less than 0.25 square mile, it is estimated that the safe yield of the water supply is only 25,000 to 50,000 gpd.

In 1957, well 251-356-11 was drilled to determine the feasibility of obtaining a ground-water supply for the town of Glenville. This 8-inch well was drilled through sand and gravel from the surface to a depth of 80 feet, and into till to a depth of 84 feet. The well was completed with 11 feet of screen between 69 and 80 feet. During a pumping test conducted by the driller (Stewart Brothers Water Wells Company) the well was pumped at a rate of about 350 gpm for 25 hours with a drawdown of 34 feet. The field coefficients of transmissibility and permeability of the sand and gravel were estimated from test data to be approximately 20,000 gpd per foot and 400 gpd per square foot, respectively. The water level in the well was slowly declining at the end of the test, and if the well had been pumped longer the water level would have continued to decline slowly until equilibrium had been achieved between recharge and discharge. Inasmuch as the pumping level was only about 6 feet above the top of the screen at the end of 25 hours pumping, the safe yield of the well would appear to be somewhat less than 350 gpm.

FLOOD-PLAIN DEPOSITS

The present streams have deposited silt and sand, along with some clay, gravel, and organic material, in their flood plains. Extensive deposits of this type are restricted to the Mohawk valley between Hoffmans and Alplaus, and to the lower part of the valley of Alplaus Kill (fig. 2 and pl. 1). The extent of flood-plain deposits in other valleys in eastern Schenectady County is too minor to be of any significance.

The flood-plain deposits are mostly the product of erosion and redeposition of older valley-fill materials. In places the materials are similar and the boundary between them is difficult to fix. These flood-plain deposits average 20 to 30 feet in thickness. However, in places, such as in the abandoned channel of the Mohawk River half a mile south of Lock 7, and at the General Electric Company in the city of Schenectady, these deposits are as much as 50 feet thick.

Water-bearing characteristics

The yield of wells drilled in flood-plain deposits generally is between 20 and 100 gpm. Wells of high yield in the flood-plain deposits obtain water from the sand and gravel lenses that are scattered through the deposits in a random manner. Pumping from some wells in the flood-plain deposits will induce infiltration from streams. The yield of such wells will generally

be greater than that of wells in the parts of the flood-plain deposits that are recharged only by precipitation. The principles of stream infiltration are described later in the report. The following descriptions of the supply wells of public and industrial water systems illustrate the water-bearing characteristics of these deposits.

Well 247-350-7 was drilled by the town of Niskayuna to determine the possibility of obtaining water to supply the town. The well is located about 50 feet from the Mohawk River and about half a mile downstream from the Vischer Ferry Dam (fig. 2 and pl. 1). The sand and gravel aquifer which was tested is part of the flood-plain deposits that fill an abandoned channel of the Mohawk River. The well was drilled through sandy clay containing silt and some gravel from the surface to a depth of about 20 feet, and through sand and gravel from 29 to 49 feet, at which depth sandy clay (till) was penetrated. The well was screened between the depths of 39 and 49 feet. During a 120-hour pumping test conducted by the driller (Layne-New York Company, Inc.) the well yielded about 350 gpm with a drawdown of about 6 feet. At the beginning of the test the static water level in the well was at the same level as the Mohawk River. During the test the level of the Mohawk River rose about 6 feet and the pumping level in the well rose an equivalent amount so that at the end of the test, which coincided with highest river level, the pumping level in the well was slightly higher than the static level at the beginning of the test. Equilibrium conditions were reached during the first few minutes of the test, and the water pumped from the aquifer was replaced by water infiltrated from the river. The transmissibility and the field coefficients of permeability of the aquifer are estimated to be about 100,000 gpd per foot and 5,000 gpd per square foot, respectively, on the basis of test data. Additional test drilling is needed to determine the extent of the aquifer and the areas of principal stream infiltration before the potential yield of the aquifer can be fully evaluated.

The water supply for Glenridge Hospital is from a group of seven screened wells (designated as one well, 252-354-6) jetted to a depth of 17 feet in sand and gravel underlying the flood plain of Alplaus Kill. In normal use these wells have been pumped at a maximum combined rate of about 50 gpm without difficulty. When first drilled in 1957, the wells were pumped at a combined rate of 200 gpm for 96 hours. Because of the position of the wells adjacent to Alplaus Kill, part of the water pumped from the well field may be infiltrated from the stream.

A number of wells have been drilled in flood-plain deposits at the General Electric Company plant on the Mohawk River flood plain in the northern part of the city of Schenectady. Most of these wells, of which well 248-358-7 is representative, penetrated sand containing some clay, silt, and gravel to depths ranging from 35 to 50 feet. The yield of the wells ranged between 30 and 400 gpm. The wells having low yields penetrated sand containing silt and clay, whereas the wells having high yields penetrated one of the discontinuous sand and gravel lenses in the flood-plain deposits. The yield of most of the wells has been insufficient for the use intended and they have been abandoned.

COARSE CHANNEL DEPOSITS

The principal deposits of coarse sand and gravel in eastern Schenectady County underlie the flood-plain deposits in the Mohawk River valley from the county line at Hoffmans downstream to the vicinity of the Schenectady and Rotterdam well fields (pl. 1 and fig. 2). Most of the coarse-grained deposits in this part of the valley were laid down at a time when stream currents were sufficiently swift and turbulent so that most of the material finer than medium-grained sand remained in suspension and only coarser grained materials were deposited. These coarser materials were laid down in an irregular sequence of beds of sand, sand and gravel, or gravel. The coarseness and uniformity of the material in any bed depends upon the swiftness of the river at the time of deposition. In the quieter parts of the river, away from the main current, sand was the principal deposit. The irregularity and discontinuity of the deposits is due to variations in the volume and velocity of streamflow and to changes in the position of the main part of the channel. Thus, the river alternately deposited, then eroded, then again deposited materials along its bed.

These deposits were examined in the sand and gravel pit on the Candage farm, about a quarter of a mile southeast of Rotterdam Junction. There they consist of alternating beds, generally 1/2 foot to 4 feet thick, of well-sorted gravel, and beds of sand and gravel (50 to 70 percent sand). A few of the beds exposed in the gravel pit are well-sorted sand which contain very little gravel. Some of the gravel beds are remarkably well sorted. One gravel bed, about 6 inches thick and extending about 10 feet along the pit face, contains only rounded pebbles 1/2 inch in diameter. Another gravel bed, about 3 feet thick and extending about 10 feet along the pit face, contains a small amount of sand but the predominant materials are pebbles and cobbles 1 inch to 4 inches in diameter. The arrangement of the pebbles in this bed is such that a pencil may be inserted into the spaces between pebbles at many places along the face of the bed to a depth of 3 to 5 inches before an obstruction is encountered. The ease with which water would move through such a gravel bed is obvious. The very high transmissibility of different parts of the coarse deposits in the Mohawk valley is due to the relative number and thickness of beds of this type that are interbedded with other units of sand and gravel which have a relatively lower permeability.

The thickness of the coarse channel deposits probably averages between 50 and 70 feet, but in places they are more than 100 feet thick. The underlying material differs locally, and is either till or bedrock. The thickness of the deposit in various parts of the area is shown in figures 8, 9, 33, and plate 3.

In many places the overlying flood-plain deposits also consist of sand and gravel but usually they contain significant amounts of silt and fine sand. Where they consist of sand and gravel, distinction between the flood-plain deposits and the underlying channel deposits is difficult to make. For this reason, and because of individual differences in observers and differences in the reliability of various sampling techniques, the graphic well logs in figures 8, 9, 33, and plate 3 should be used and interpreted with great care. The individual unit symbols reflect only the principal grain sizes without reference to the range or amount of less abundant grain sizes which may be present.

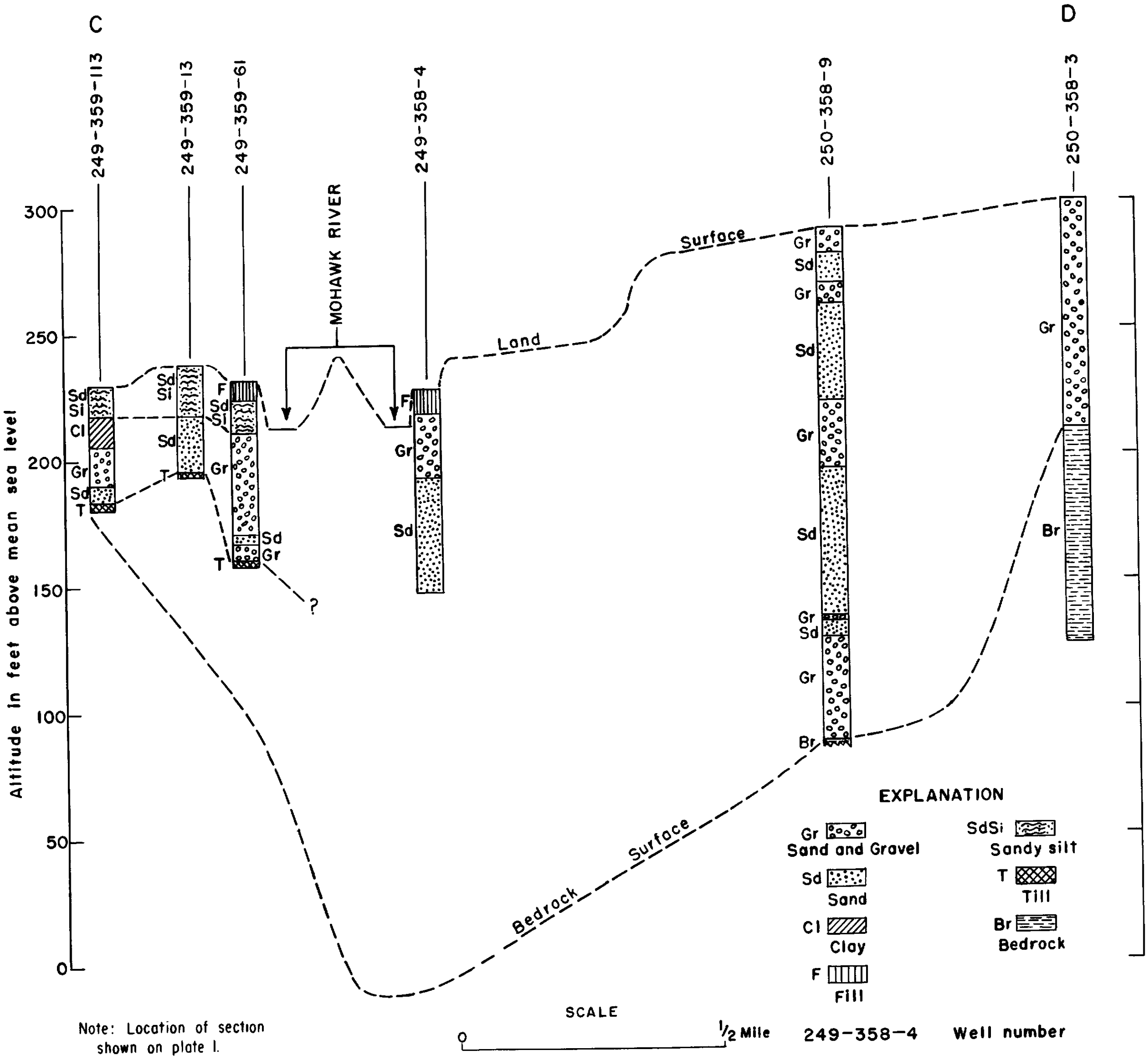

Figure 9.--Geologic section across the Mohawk valley from the Schenectady well field to Scotia.

Water-bearing characteristics

Almost all the large-capacity wells in eastern Schenectady County are drilled in the coarse sand and gravel deposits in the Mohawk valley. One of the reasons for this is the exceptional permeability of the deposits. A second reason is that all the wells in these deposits derive (or potentially derive) part of the water pumped by infiltration from the Mohawk River, hence, large quantities of water are available. Some of the wells in these coarse sand and gravel deposits yield more than 3,500 gpm. The principles of stream infiltration are described in a later section of this report entitled "Stream Infiltration from the Mohawk River."

Descriptions of a number of water supplies in the coarse channel deposits are presented below. Whereas the deposit may be continuous between several of these water supplies, the distance between them and the proximity of the wells to the river permits each supply to be discussed as if it were in a separate aquifer.

Rotterdam Junction water supply.--The water supply for Rotterdam Junction in the town of Rotterdam is from wells 252-402-15 and -16. (See plate 1.) Well 252-402-15 was drilled through silty sand and gravel from the surface to a depth of 50 feet and then through coarse sand and gravel to the underlying till surface at a depth of 86 feet. During a pumping test on this well, conducted by the U.S. Geological Survey, the drawdown was about 0.7 foot after pumping at a rate of 520 gpm for 24 hours. At the time of the test (November 1960), the water level in the aquifer at the well field was at an altitude of about 228 feet (32 feet below land surface). The transmissibility and field coefficient of permeability of the aquifer, as calculated from the test data, are about 5,000,000 gpd per foot and 100,000 gpd per square foot, respectively. The water level in the aquifer rises and falls with the Mohawk River level and the hydraulic connection between the aquifer and the river appears to be excellent.

The water level in the well field is intermediate in altitude between the levels of the upper and lower pools of Lock 9. The navigation and non-navigation season pool levels (altitudes) of the Mohawk River are, respectively, 241 and 225 feet above Lock 9 (slightly upstream from the well field) and 226 and 216 feet below Lock 9 (fig. 2). During the navigation season the altitude of the water level in the well field is about 228 feet. During the non-navigation season in February 1961, the water level in the well field dropped to about 219 feet. It would probably have dropped to an altitude of about 217 feet except for the slugs of recharge that entered the aquifer during winter floods. Such flooding, and resultant recharge, is common during the later part of the non-navigation season. The fact that the water levels in the wells are higher than the water in the lower pool at Lock 9 suggests underflow around the dam. It is evident that a significant gradient exists across the dam throughout the year, ranging from 15 feet during the navigation season to about 9 feet during the non-navigation season. For this reason, underflow through the aquifer occurs throughout the year. Underflow occurs not only around the immediate ends of the dam, but probably also through the full width of the aquifer underlying the flood plain.

Knowledge of the extent of the aquifer in the vicinity of Rotterdam Junction is scant, and an extensive test drilling program would be needed to fully plan the optimum development of this aquifer. The average maximum pumpage from the aquifer by Rotterdam Junction in the summer of 1961 was about 125,000 gpd, which is a small amount in comparison with the amount of water that is potentially available.

Schenectady Chemical Company.--Most of the water supply for the Schenectady Chemical Company, located a mile southeast of Rotterdam Junction, is obtained from one of four wells. The principal well (251-401-15) was

drilled through coarse sand and gravel to the surface of the underlying till, 52 feet below land surface. This well was drilled in a gravel pit, hence, it did not penetrate flood-plain deposits. The specific capacity of the well as determined during a pumping test made by the driller (Stewart Brothers Water Wells Company) in 1942, is about 350 gpm per foot of drawdown. From the test data the transmissibility and the field coefficient of permeability of the aquifer are estimated to be about 600,000 gpd per foot and 15,000 gpd per square foot, respectively. During the summer months, when the level of the Mohawk River in the vicinity of the plant is maintained at an altitude of about 226 feet above sea level, the well is supplied by ground water from local precipitation and water infiltrated into the aquifer from the river. In winter, the normal level of the Mohawk River is at an altitude of about 215 feet, which is only about 5 feet higher than the bottom of the aquifer between well 251-401-15 and the river. Because only a low hydraulic gradient can be developed between the river and the well in winter, little infiltration can be induced by pumping. Well 251-401-15 could not be pumped at a rate greater than about 500 gpm in February 1961, when ground-water levels were below normal due to the absence of mid-winter floods to recharge the aquifer. The yield of the aquifer in this area probably ranges from about 3 mgd during the navigation season to less than 1 mgd in the winter months. In the winter months during periods of flood, or when the river level is temporarily higher owing to ice jams, the yield of the aquifer is more than 1 mgd. The average water use by the company (mostly water for cooling) was about 1 mgd prior to the installation of water conservation equipment in the spring of 1962. After the installation of this equipment, pumpage was estimated to be about 300,000 gpd.

Test holes drilled in the plant area, between the Boston and Maine Railroad and the Mohawk River, penetrated only flood-plain deposits to the till surface, and did not penetrate coarse sand and gravel. Evidently, the principal area of stream infiltration to the aquifer is along the river southeast of the well.

<u>Town of Glenville test well south of Rectors</u>.--Well 251-401-11 was drilled on the flood plain of the Mohawk River south of Rectors to determine the availability of water for a prospective supply for the town of Glenville (pl. 1). This site is across the river and about half a mile southeast of the well at the Schenectady Chemical Company described above. The well was drilled through silty sand and gravel from land surface to a depth of 18 feet, and through coarse sand and gravel from 18 feet to the till surface at a depth of 51 feet. The well was equipped with a screen 10 feet long placed just above the till surface. During a pumping test conducted by the driller (Stewart Brothers Water Wells Company), in January 1958, the well was pumped at a rate of 740 gpm for a period of several days. Drawdown in the well became essentially constant at 0.6 foot after 4 hours of pumping. The altitude of water level in the well and in the river was about the same at the start of the test. During the test river level rose slightly more than 2 feet and the pumping level in the well at the end of the test was nearly a foot higher than the static level at the beginning of the test. The transmissibility and the field coefficient of permeability of the aquifer were calculated, on the basis of the pumping test data, to be about

1,200,000 gpd per foot and 35,000 gpd per square foot, respectively. It is apparent that infiltration from the river to the aquifer occurred during the test.

The effective transmissibility and permeability of the aquifer would be higher during the summer months because river level is about 12 feet higher and river temperature is also higher. Additional test drilling, pumping tests, and location of principal recharge area would be necessary before the yield of a well field in this area could be evaluated.

City of Schenectady test well above Lock 8.--The city of Schenectady drilled an exploratory well (250-400-3) on the Vrooman farm about 1 mile northwest of Lock 8 in the town of Rotterdam. The well was drilled through silty sand from the surface to a depth of 6 feet, through silty sand and gravel from 6 to 26 feet, and through coarse sand and gravel from 26 feet to the till surface at a depth of 52 feet. The well is screened between depths of 35 and 50 feet. The well was pumped at a rate of 440 gpm with a drawdown of 14 feet after 34 hours during a test conducted by the driller (J. A. McQueen and Son). The altitude of water level in the well and in the river were essentially the same at the start of the test. The transmissibility and the field coefficient of permeability of the aquifer are estimated to be about 55,000 gpd per foot, and 1,600 gpd per square foot, respectively. The water level in the aquifer responds quickly to changes in river level, indicating a hydraulic connection between the aquifer and the river. A well field installed in this area would induce infiltration from the river. Further exploration would be needed before development to determine the extent of the aquifer and the area of stream infiltration in order to plan for optimum development of the aquifer.

Scotia Naval Depot.--The water supply for the Scotia Naval Depot during World War II was from well 250-358-9. The well penetrated principally sand, and sand and gravel from the land surface to the top of bedrock at a depth of 203 feet. The coarsest material was penetrated between depths of 162 and 202 feet. The well was equipped with 30 feet of screen placed between depths of 172 and 202 feet. When drilled the well had a drawdown of 38 feet at a pumping rate of 1,265 gpm. The transmissibility and the field coefficient of permeability of the aquifer are estimated to be 60,000 gpd per foot and 400 gpd per square foot, respectively. The sand and gravel penetrated by the well is believed to be continuous with the coarse channel deposits under the Mohawk River. The pumping level in the well was 14 feet or more below river level, and it is possible that a small amount of river water was infiltrated to the aquifer during the test. In 1962 the well was on a stand-by basis, and water for the Naval Depot was obtained from the village of Scotia water supply system.

Scotia water supply.--The water supply for the village of Scotia is from three wells (250-358-1, 2, and 10). The wells penetrated mostly sands and gravels from land surface to the surface of the underlying till at depths ranging between 70 and 98 feet. Two wells have screens 24 feet long,

and one has a 30-foot screen, all of which are installed just above the till. The yield of the individual wells is 1,100 gpm or more. On the basis of pumping tests conducted by the U.S. Geological Survey and the driller of one of the wells (Stewart Brothers Water Wells Company), the transmissibility and the field coefficient of permeability of the deposits is calculated to be about 800,000 gpd per foot and 20,000 gpd per square foot, respectively.

The natural recharge from precipitation over about 3 square miles of Glenville Hill, north of the well field, is discharged to a stream that crosses the cone of depression around the well field and water is infiltrated from the stream into the aquifer. The maximum safe yield of the aquifer is estimated to be between 2 and 3 mgd, or a little more than twice the average daily pumping rate in 1961.

The level of the Mohawk River is at an altitude of about 226 feet in the upper pool of Lock 8 during the navigation season and about 213 feet during the non-navigation season. The altitude of the lowest water level recorded in the aquifer was about 226 feet (in 1941 and 1957; fig. 11; and Simpson, 1952, fig. 7), and the altitude of the till surface, which the aquifer overlies, ranges between 180 and 200 feet.

It is possible that the water level in the aquifer at the well field might be lowered sufficiently by pumping to induce some infiltration from the Mohawk River. However, the amount of stream infiltration would be slight because the distance between the well field and the river is nearly a mile.

HOW TO USE THE GROUND-WATER RESOURCES MAP (PLATE 1)

Plate 1 is a key to the ground-water resources of the project area which will quickly provide information as to the source and amount of water available from wells in any part of the area.

Use of the map is most readily explained by a specific example. Assume that someone is interested in determining the availability of ground water in the area immediately southwest of the Schenectady County Airport, in the vicinity of wells 250-356-4 and -10. Information needed would be the character and thickness of the principal water-bearing material, the approximate yield of wells in these materials, and details of well construction.

The letters "Qss," shown in black slightly to the left and below well 250-356-10 indicate that the surficial material in this area (bounded by the dashed line) is predominantly sand. The well location symbol for wells 250-356-4 and -10 is a solid black circle which indicates that the principal water-bearing material of both wells is sand and gravel. The particular blue color in this part of the map indicates that the yield of a properly constructed well in this area is between 20 and 100 gpm. Brief descriptions of the water-bearing materials can be found under the heading, "EXPLANATION," which is shown at the right side of the plate. The light contours indicate the altitude of the land surface in the area of the two wells to be about 320 feet. The bedrock surface in this area, interpolating between the

200-foot and 300-foot heavy contour lines, is at an altitude of about 225 feet. By subtracting the altitude of the bedrock surface from that of the land surface, it is found that the depth to the bedrock surface is about 95 feet. This means that a well drilled in the area would penetrate about 95 feet of unconsolidated materials before entering bedrock.

The specific data on wells 250-356-4 and -10, and for other wells shown on the map (pl. 1), are given in table 9 at the end of the report. The materials penetrated in the course of drilling well 250-356-10, and many other wells shown on the map, are shown graphically in figure 33.

GROUND-WATER RECHARGE

Water-table fluctuations

Under most natural conditions the water table rises and falls on a seasonal basis depending on recharge and discharge. In areas unaffected by nearby streams or by pumping, or affected only to a slight degree, the plot of the position of the water table with respect to time is a distinctive type of curve common to most aquifers in New York. It rises in the spring and declines in summer and fall in a cyclic manner.

Figure 10 shows the hydrograph of well Sa 1072 at Saratoga National Historical Park and the monthly precipitation at Saratoga Springs in 1960. This well is located about 22 miles northeast of Schenectady. It is in an area of sandy soils similar to those in the area of lake sand in eastern Schenectady County, and the water level in the well is essentially unaffected by pumping. The water-level record from this well is used here to illustrate ground-water fluctuations in the general area under natural conditions. Similar suitable records are not available within the project area. The water table in the vicinity of well Sa 1072, as represented by the water level in the well, rose in the early part of the year when water was available for recharge. Thaws during January, February, and March allowed some recharge from melting snow. The principal period of recharge occurred in April, coincident with the general spring thaw. During the growing season and the latter part of the year there was little or no water in excess of evaporation and transpiration needs available for recharge, and the water table generally declined. However, some recharge occurred in September when 4.69 inches of rain fell in the period September 10-14, as a result of a tropical storm (Hurricane Donna). The rainfall of this period was more than sufficient to replenish the soil moisture and the excess became ground-water recharge which raised the water table. Some recharge also occurred during October and November but because it was less than the ground-water discharge from the aquifer to streams, the water table declined slightly. December was cold and precipitation was in the form of snow so that no recharge occurred and the water table continued to decline.

The seasonal fluctuations of the water table are generally not more than a few feet. Under natural conditions the range of fluctuation of the water table is about the same from year to year because the average discharge from an aquifer is approximately equal to the average recharge. The average level of the water table in any year is related to the amount of

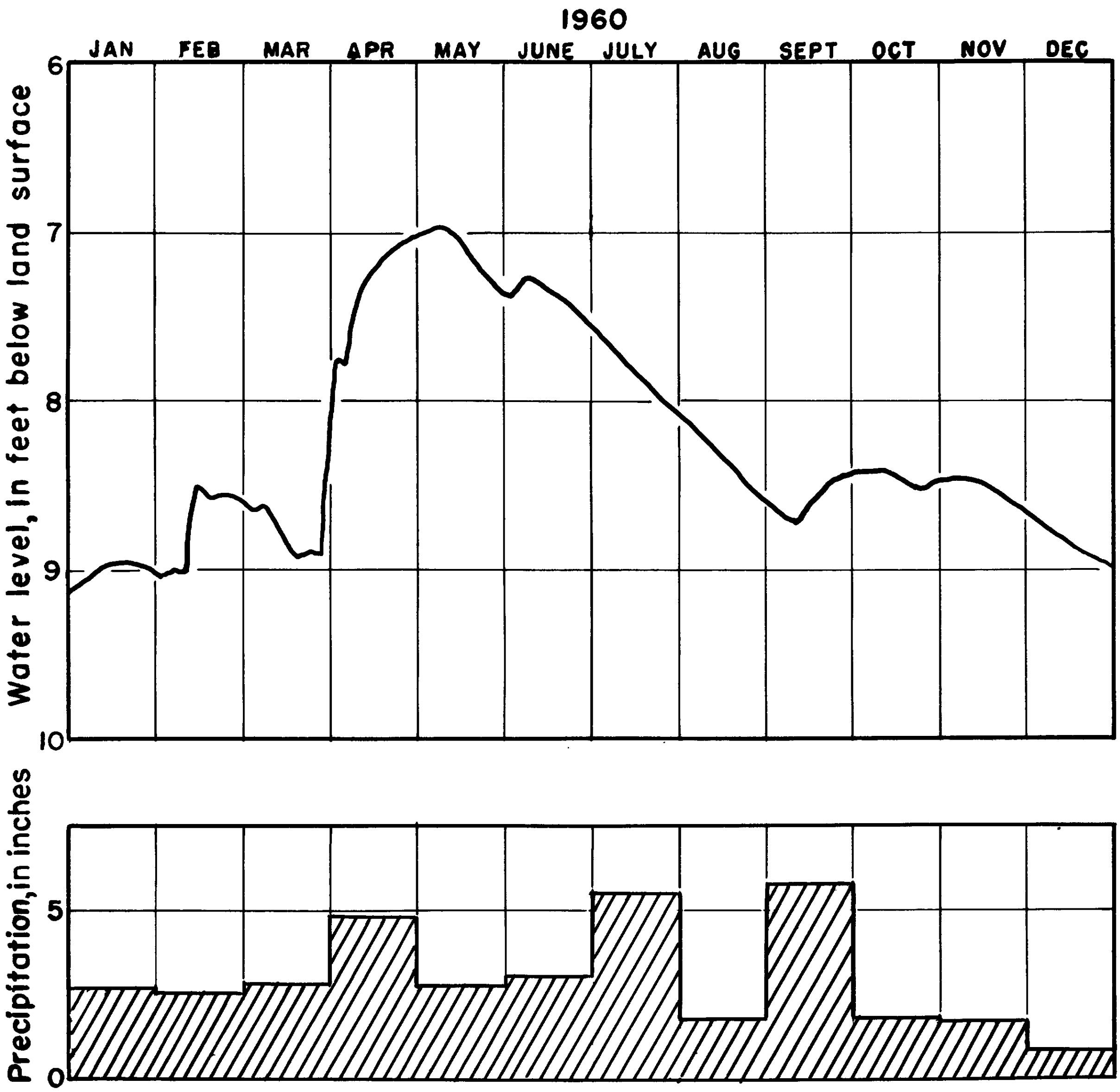

Figure 10.--Fluctuations of water level in well Sa 1072, Saratoga National Historical Park, Saratoga County, N. Y., and precipitation at Saratoga Springs in 1960.

ground-water recharge in that year. For this reason the average level of the water table will generally be slightly higher in wet years and slightly lower in dry years. If, however, from year to year the total discharge from an aquifer (pumping and natural) exceeds the recharge to the aquifer, the high and low position of the water table will decline in successive years.

Figure 11 is the hydrograph of well 250-358-11 at the Scotia well field for the period 1952-60. It is an extension of the hydrograph of this well shown by Simpson (1952, fig. 7) for the period 1931-51. The well is strongly affected by nearby pumping. Figure 11 shows the same pattern of water-level

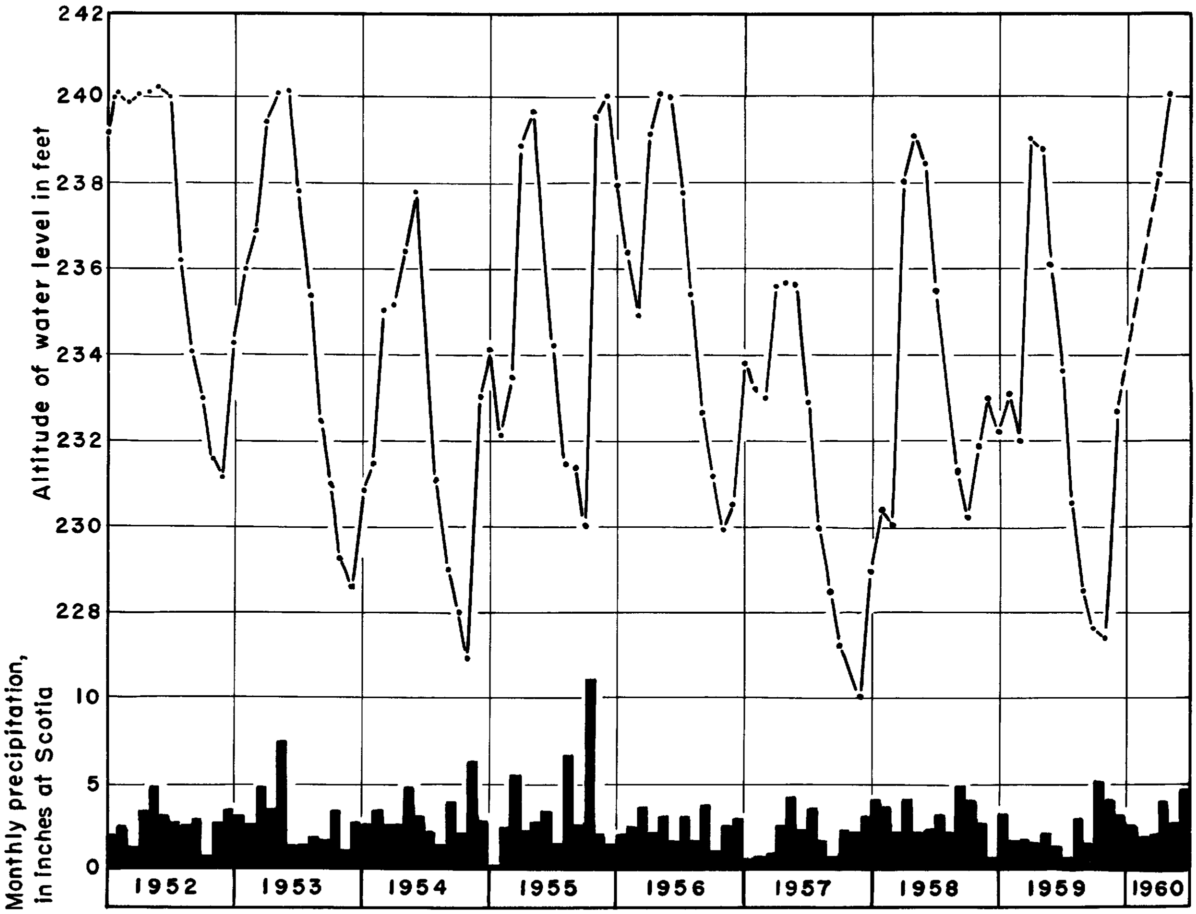

Figure 11.--Hydrograph of well 250-358-11 at the Scotia well field and a graph of monthly precipitation at Scotia (1952-60).

fluctuation that was indicated in Simpson's report. During the period 1931-51, the annual highest water level was generally between the altitudes of 237 and 240 feet. The altitude of the lowest annual water level during the same period was about 226.5 feet (1941). Figure 11 shows that the highest annual water levels during the period 1952-60 was generally about the same as in earlier years. The altitude of the lowest annual level during the period 1952-60 was 226 feet (1957). The records of this well indicate that there has been no progressive decline of water level, and that withdrawal of water from the aquifer has not exceeded available recharge. Progressive decline of water levels on a year to year basis is not known in eastern Schenectady County.

Mechanics of recharge

The soil zone of an area plays an important role, along with the climate, in determining the amounts of ground-water recharge and direct surface runoff. The soil zone is that zone, a few feet thick, immediately

underlying the land surface, which supports the growth of plants. Usually the material in the soil zone has been altered from the parent material that underlies it by the agents of weathering (rain, wind, frost, heat, etc.). Soils in areas of sand will generally be sandy and relatively permeable, whereas soils in areas of clay will be clayey and relatively impermeable.

The rate at which rain is absorbed by a soil is called the infiltration capacity of the soil. If the rate of rainfall exceeds the infiltration capacity, the excess water will move over the land surface to streams. If the infiltration capacity of the soil is greater than the rate of rainfall, all of the precipitation will be absorbed by the soil zone until the water-holding capacity is exceeded, at which time the water will begin to percolate downward, through the zone of aeration, to the water table. The infiltration capacity of a sandy soil is high, and it is low for a clay soil.

The amount of water that can be held in the soil zone is termed the water-holding capacity of the soil. It is expressed as the number of cubic inches of water that can be held in a column of soil 1 inch square and 1 foot high against the pull of gravity. The water-holding capacity ranges from about 4 inches of water per foot of soil thickness for clay soils of the type found in the hilly parts of the Schenectady area, to less than 1 inch per foot of soil thickness for sandy soils such as those northeast of Scotia and south of Schenectady. A soil is said to be saturated when the amount of water in the soil is the same as the water-holding capacity.

During a period of intense rainfall, sandy soils are rapidly saturated and downward percolation is quickly initiated because of high infiltration capacity and relatively low water-holding capacity. Equally intense rainfall on an area of clay soils may not even saturate the soils because of their low infiltration capacity, and most of the rainfall runs off over the land surface to streams. For these reasons, the streams draining an area of clay soils usually flood after a period of intense rain, whereas little difference in flow may be noticed in streams draining an area of sandy soils. (Conversely, in dry weather, streams draining an area of clay soils have low discharge or are dry, whereas streams draining areas of sand generally have a moderately high sustained flow.)

The degree of soil saturation at the time of rainfall also is a factor in the amount and rate of infiltration. During the early part of the year, before the growing season is well established, precipitation and snowmelt are generally more than adequate to maintain and replenish soil moisture, and to furnish a significant amount of ground-water recharge. Soil moisture is depleted by evaporation during periods when the air temperature is above freezing. The rate of evaporation increases with temperature. Transpiration by plants during the growing season further depletes soil moisture. When soil moisture is low the water infiltrating from precipitation must first replenish the soil moisture and exceed the water-holding capacity of the soil before recharge to the zone of saturation can occur. Because of the higher rates of soil moisture depletion during the growing season, most of the precipitation during this period only partially replenishes soil moisture. Hence, little or no recharge reaches the water table. During the fall, soil moisture and ground-water levels are low. They are seldom replenished before

freezing weather begins. During the winter months recharge is generally prevented by frozen ground, and can only occur during periods of thawing.

Quantity available

The amount of water available for use by man in an area is equal to the precipitation on the area minus losses due to evapotranspiration (evaporation plus transpiration). The remainder is streamflow which includes direct surface runoff and ground-water discharge to streams. Most of the hydrologic factors that determine the amount and distribution (with time) of streamflow are difficult to measure accurately. Precipitation can vary widely, even over small areas, and evapotranspiration from an area is dependent on precipitation, temperature, type of vegetation, type of soil, the slope of the land surface, and other factors.

A method of evaluating some of these hydrologic factors, called the "water balance method," has been developed by Thornthwaite and Mather (1955, 1957). This method was applied to an inventory of available water in the Schenectady area. The climatic factors that enter into Thornthwaite's method of calculating the water balance are precipitation and temperature. In addition, the method also takes into account the seasonal variation in the length of day and the character of the soil and vegetation. For computing the water balance shown in table 2, the water-holding capacity of the soil (4 feet thick) was assumed to total 4 inches for sandy soils and 10 inches for clayey soils (Thornthwaite and Mather, 1957, table 10). These values are estimated to be average values for the soils in the project area. The clayey soils include both those developed from till and those developed from thin-bedded silt and clay. Vegetation is assumed to be principally brush and grass.

The factors of the water balance shown in table 2 are based on U.S. Weather Bureau records for Schenectady and are for a sandy soil and a clay soil. The calculated amount of surplus water (S) available for direct surface runoff and ground-water recharge in sandy soil areas in a year of average precipitation and temperature is 11.90 inches, or about 570,000 gpd per square mile. The calculated surplus available in the wettest year (1951) with annual precipitation of 47.15 inches, is 20.81 inches or 990,000 gpd per square mile. In the driest year (1930), with annual precipitation of 23.72 inches, the calculated water surplus is 430,000 gpd per square mile. The calculated water surplus for the clay soil in a year of average precipitation and temperature is about 510,000 gpd per square mile. Potential evapotranspiration (based on temperature and length of day) is about 73 percent of precipitation in the average year, and actual evapotranspiration (potential evapotranspiration corrected for precipitation and soil moisture condition) is about 66 percent of precipitation for sandy soils in the average year.

The amount of surplus water available in a year is controlled more by the distribution of precipitation than by the total amount during the year. Thus, a wet year in which almost all of the precipitation fell during the growing season could have a lower water surplus than a dry year in which

Table 2.--Factors of the water balance for sandy soil and clay soil at Schenectady

All values in inches of water except T which is temperature in degrees Fahrenheit

Period of Data and soil material	Factor 1/	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Sandy soil Mean monthly precipitation and temperature (1925-1961)	T	21.5	21.9	32.5	45.1	58.1	68.0	72.7	70.4	61.8	50.3	38.6	25.9	47.2
	P	2.42	2.22	2.69	3.05	2.98	3.86	3.57	3.27	3.26	2.66	2.84	2.43	35.25
	PE	0	0	0	1.34	3.40	5.00	5.80	5.00	3.10	1.71	.49	0	25.84
	ST	8.85 2/	11.07	4.00	4.00	3.59	2.68	1.51	.97	1.13	2.08	4.00	6.43	
	AE	0	0	0	1.34	3.39	4.77	4.74	3.81	3.10	1.71	.49	0	23.35
	S	0 3/	0 3/	9.76 4/	1.71	0	0	0	0	0	0	.43	0 3/	11.90 5/
Sandy soil 1930 (Driest year, 1925-1961)	T	26.6	29.7	36.0	46.2	60.1	72.1	73.5	68.9	62.1	50.0	40.3	29.1	49.6
	P	2.46	1.10	3.11	1.57	2.79	3.75	1.95	1.08	1.44	1.23	2.38	.86	23.72
	PE	0	0	.31	1.34	3.40	5.38	5.79	4.68	3.12	1.71	.49	0	26.22
	ST	8.92 2/	10.02	4.00	4.00	3.42	2.25	.84	.34	.18	.15	2.04	2.90	
	AE	0	0	.31	1.34	3.37	4.92	3.36	1.58	1.60	1.26	.49	0	18.23
	S	0 3/	0 3/	8.82 4/	.23	0	0	0	0	0	0	0	0 3/	9.05 6/
Sandy soil 1951 (Wettest year, 1925-1961)	T	26.2	27.4	35.9	48.0	59.4	66.1	71.9	68.5	60.4	52.1	34.8	28.2	48.2
	P	2.28	3.26	4.23	2.57	2.67	4.84	3.63	5.89	4.34	5.14	3.96	4.34	47.15
	PE	0	0	.31	1.67	3.40	4.60	5.80	4.68	3.10	1.71	.24	0	25.51
	ST	9.98 2/	13.24	4.00	4.00	3.31	3.53	1.92	2.62	3.60	4.00	4.00	8.34	
	AE	0	0	.31	1.67	3.40	4.60	5.24	4.68	3.10	1.71	.24	0	24.95
	S	0 3/	0 3/	13.16 4/	.90	0	0	0	0	0	3.03	3.72	0 3/	20.81 7/
Clay soil Mean monthly precipitation and temperature (1925-1961)	T	21.5	21.9	32.5	45.1	58.1	68.0	72.7	70.4	61.8	50.3	38.6	25.9	47.2
	P	2.42	2.22	2.69	3.05	2.98	3.86	3.57	3.27	3.26	2.66	2.84	2.43	35.25
	PE	0	0	0	1.34	3.40	5.00	5.80	5.00	3.10	1.71	.49	0	25.84
	ST	14.09 2/	16.31	10.00	10.00	9.59	8.60	6.87	5.78	5.94	6.89	9.24	11.67	
	AE	0	0	0	1.34	3.39	4.85	5.30	4.36	3.10	1.71	.49	0	24.54
	S	0 3/	0 3/	9.00 4/	1.71	0	0	0	0	0	0	0	0 3/	10.71 8/

1/ Abbreviations: T, monthly mean air temperature; P, precipitation; PE, potential evapotranspiration; ST, moisture retained in the soil; AE, actual evapotranspiration; S, surplus water (total available runoff either to surface streams or to ground-water recharge).

2/ Includes water in storage as snow on surface from preceding month.

3/ Does not include water in storage as snow on surface.

4/ Includes water held in storage as snow during preceding months when average temperature was below freezing.

5/ 0.57 mgd per square mile.

6/ 0.43 mgd per square mile.

7/ 0.99 mgd per square mile.

8/ 0.51 mgd per square mile.

almost all of the precipitation fell in the non-growing season. Therefore, the water surplus was computed on a monthly basis rather than on an annual basis, so that the distribution of precipitation through the year could be taken into account.

Short-term variations in precipitation and soil conditions may significantly change the factors of the water balance as computed on a monthly basis. During the winter months, precipitation that falls when the mean monthly temperature is below freezing is assumed to be in storage on the surface as snow until March or April when the mean monthly temperature rises above freezing. (See table 2.) However, most of the snow on the ground usually melts during brief thaws which occur one or more times during most winters. At these times soil moisture is replenished and ground-water recharge and direct surface runoff occur. Hence, at such times daily computations would improve the accuracy of the method.

Evapotranspiration probably would account for all the rain that falls during the growing season if the rainfall were distributed evenly through the season. During the summer, moisture retained in the soil (ST, table 2) is generally sufficiently below the water-holding capacity of the soil so that normal evapotranspiration can more than account for the amount of precipitation added to the soil. However, when several inches of rain falls in one intense storm, the excess over that required to replenish the soil becomes ground-water recharge and/or direct surface runoff. Daily computations, therefore, would also improve accuracy with respect to summer rainfall. However, because only monthly values were used, no surplus is shown in table 2 for months of the growing season. Actually, some ground-water recharge and/or direct surface runoff does occur during a few brief periods of the growing season, but the amount is generally insignificant except during tropical storms or other relatively rare events.

Thus, it is apparent that the most accurate results are obtained with the Thornthwaite method if computations are made on a daily basis. However, an almost prohibitive amount of time is required to make the number of computations needed and the increased accuracy is unnecessary in the present study.

Table 2 indicates a water surplus of 570,000 gpd per square mile in an area of sandy soils during an average year. For these areas most of the water surplus becomes ground-water recharge. In areas of clay soils, table 2 shows the water surplus to be 510,000 gpd per square mile. However, only a small part of this goes into ground-water recharge. In such areas the infiltration capacity of the soils is very low and the land-surface slopes are generally relatively steep, therefore, much of the water surplus runs directly off the surface to streams.

A value of 500,000 gpd per square mile for average ground-water recharge in areas of sandy soils is believed to be a safe value for water-resources planning.

STREAM INFILTRATION FROM THE MOHAWK RIVER

PRINCIPLES OF STREAM INFILTRATION

When a well is pumped the water is withdrawn from storage in the immediate vicinity of the well, and the water level in the aquifer around the well declines. The resulting difference in water levels between the pumped well and the surrounding area provides the hydraulic gradient necessary for water to move through the aquifer to the well. The depression of water level in the aquifer around the well is called the cone of depression, and it expands until enough recharge is intercepted to equal the amount of water pumped from the well. If a well is located adjacent to a lake or a stream, such as the Mohawk River, so that the cone of depression intersects the stream, part of the water pumped will be infiltrated from the stream. The amount of water that can be infiltrated from the stream depends on the transmissibility of the streambed and of the aquifer, and the hydraulic gradient between the stream and the well.

Another very important factor governing the amount of stream infiltration is the temperature of water in the stream and the temperature of the water reaching the well. Cold water is more viscous than warm water, the viscosity varying inversely with the temperature. An increase of $1^{\circ}F$ in the temperature of ground water will increase the rate of flow about 1 1/2 percent. The effect of the change of viscosity is such that at a water temperature of $32^{\circ}F$ the hydraulic gradient must be nearly double what it would have to be at $80^{\circ}F$ for an aquifer to transmit an equal amount of water.

The adjacent well fields of the city of Schenectady and the town of Rotterdam are supplied in large part by water infiltrated from the Mohawk River, a fact first noted by Simpson (1952, p. 60-61). Smaller infiltration supplies have been developed in eastern Schenectady County, and additional areas where such supplies can be obtained have been explored and tested. These have been briefly discussed in earlier parts of this report. The following discussion of the well fields of the city and town will evaluate the geologic and hydrologic factors affecting infiltration supplies from the Mohawk River, and to this extent the discussion will also apply to the smaller installations and the tested areas.

The hydrologic factors that were studied are: (1) the change of well yield with time; (2) the permeability, thickness, and areal extent of the aquifer; (3) the relationship between river levels and water levels in the aquifer; (4) the areas of principal infiltration to the aquifer; and (5) the effect of river and ground-water temperature on the yield of the aquifer. All these factors are, more or less, simultaneously active and it is difficult to differentiate the cause or effect of each change of river level or temperature, each change of pumping rate in the well fields, or each change of

water level in the aquifer. For this reason each of the factors will be discussed separately and illustrated by interpretation of pertinent data.

SCHENECTADY AND ROTTERDAM WATER SUPPLIES

The water supplies for the city of Schenectady and the town of Rotterdam are obtained from wells in an exceptionally permeable coarse sand and gravel aquifer which underlies the flood plain of the Mohawk River. The adjacent well fields are located about 2 miles west of Schenectady. (See plate 2 and figure 2.) The water supply for Schenectady has been obtained from wells in this area since 1897. Between 1897 and 1944 the supply was from three large-diameter dug wells (249-359-96, -97, and -98) (pl. 2). In 1940 the demand approached the yield of the dug wells and well 249-359-75 was drilled about 1,200 feet south of the old wells to supplement the supply. In 1942 and 1943, nine additional wells (249-359-76 through -84) were drilled in the aquifer immediately south of well 249-359-75. These wells were placed in operation in 1944 and the old dug wells were abandoned. Two additional wells (249-359-94 and -95) were drilled in 1954 at the south end of the new well field.

In 1953, the town of Rotterdam initiated pumping from three wells (249-359-91, -92, and -93) which were drilled in the aquifer between the Schenectady well field and the Mohawk River (fig. 2 and pl. 2). During the period of this investigation (1959-63), combined pumpage from the two well fields has ranged between a low of about 12 mgd and a high of about 36 mgd, and average pumpage has ranged between about 15 mgd in winter and 25 mgd in summer.

Many test wells were drilled in the vicinity of the well fields between 1917 and 1954 to determine the extent and thickness of the aquifer. A few of these test wells were still in existence at the time of the present investigation. They were utilized, along with additional new observation wells, to study the hydrology of the aquifer.

DESCRIPTION OF WELLS

In the spring of 1962, the city of Schenectady water supply was from 12 wells (249-359-75 through -84, -94, and -95) in coarse sand and gravel, located about 1,200 feet from the Mohawk River (pl. 2). Nine of the wells were drilled along a line at 50-foot intervals, and the other three were drilled nearby, but with slightly greater spacing. The wells range in diameter from 12 to 24 inches and they range in depth from 56 to 71 feet. The wells are drilled to, or within a few feet of, the bottom of the coarse sand and gravel unit of the aquifer. The lower 19 or 20 feet of each well is screened and gravel packed. The town of Rotterdam obtains its supply from three wells (249-359-91, -92, and -93), in the same aquifer, located about 400 feet from the Mohawk River. The wells range in diameter from 12 to 24 inches and are 81 to 82 feet deep. The lower 19 to 20 feet of these wells is also screened and gravel packed in the bottom of the coarse sand and gravel unit of the aquifer.

The yield and specific capacity (yield in gpm per foot of drawdown) of some of the wells in the Schenectady well field have decreased considerably since they were drilled. The decrease is due to slow partial clogging of the well screens. Table 3 shows the original specific capacity of these wells and the specific capacity during 1958-61. The slight drawdown of water level in observation wells within a few feet of a pumping well, in comparison with the significant drawdown within the pumping well, indicates that the clogging is restricted to the well screen and possibly, to a slight extent, to the gravel pack immediately around the screen. The effect of clogging may be illustrated with data from well 249-359-79 which was drilled in 1942. The yield when drilled was 3,570 gpm with a drawdown of 2.3 feet. The same well had a drawdown of 24 feet, or a specific capacity of 46 gpm per foot of drawdown, when pumped at a rate of 1,100 gpm on April 25, 1960. The drawdown in observation well 249-359-90, about 10 feet distant, was 0.17 foot at the same time.

This decline is due to clogging of the well screen by what appears to be silt from the aquifer and by a filamentous black flocculant. A sample of the flocculant was collected from well 249-359-82, and chemical analysis showed that it contained 16.4 percent iron (Fe) and 13.3 percent manganese (Mn). The sample was not analyzed for other constituents. The filamentous character of the flocculant suggests that it is a precipitate of iron and manganese oxide resulting from bacterial action.

In order to determine something of the environment in which the flocculant occurs, the dissolved oxygen content of the Mohawk River and water from four wells in the Schenectady and Rotterdam well fields was determined on October 24, 1960. The amount of dissolved oxygen in four samples of river water ranged from 10.4 to 11.0 parts per million (ppm), or 90 percent or more of the total saturation possible. The dissolved oxygen content of wells 249-359-26, -33, -36, and -84 (table 4) ranged from 0.1 to 0.4 ppm or less than 5 percent of the total saturation possible. Most of the oxygen in the samples from the wells is believed to have entered the samples from the air as it was being collected and prior to analysis in the field. It thus appears that the black flocculant exists under reducing conditions, and that if bacteria are involved in its formation they are anaerobic. The loss of oxygen from the water during its travel through the aquifer from the river to the wells may be accounted for by oxidation of organic matter and aquifer material or by bacterial processes enroute.

In order to restore the efficiency and specific capacity of the affected wells, they are periodically backflushed by alternately injecting water into a well and then pumping it. This operation loosens and removes some of the flocculant and increases the specific capacity to some extent, as shown in table 3. It is to be noted that this backflushing is accomplished without removing the pump from the well, thereby restricting the effectiveness of the technique. A more adequate technique was used early in 1963.

In February 1963, the specific capacity of well 249-359-80 had dropped to 50 gpm per foot of drawdown, and was breaking suction at a pumping rate of 900 gpm. The condition of the well obviously had deteriorated after

Table 3.--Yield and specific capacity of production wells in the Schenectady and Rotterdam well fields

Well number	Well field and owner's well number	Depth (feet)	Feet of screen	Year drilled	Yield when drilled (gpm)	Draw-down (feet)	Specific capacity when drilled (gpm per foot)	Specific capacity 1958-61 Before backflushing	Specific capacity 1958-61 After backflushing
249-359-75	Schenectady 1	67	20	1940	2,060	1	2,060	855 1/	
76	2	62	19	1942	3,555	3.3	1,080	380 2/	392 2/
77	3	70	19	1942	3,555	6.9	515	120	139
78	4	71	20	1942	3,570	9.2	390	78	97
79	5	62	20	1942	3,570	2.3	1,550	46	117
80	6	56	19	1942	3,600	3.4	1,060	104	133
81	7	69	20	1942	3,540	6.9	510	49	88
82	8	69	19	1943	3,570	2.9	1,230	87	133
83	9	67	19	1943	3,570	3.5	1,020	49	184
84	10	66	19	1943	3,540	2.9	1,220	--	--
94	11	69	20	1954	2,873	2.0	1,440	2,170 1/	
95	12	71	20	1954	2,980	1.5	1,980	720 1/	
91	Rotterdam 1	82	19	1949	1,083	3.5	310	--	--
92	2	82	20	1952	2,300	4.0	575	--	--
93	3	81	20	1952	1,869	4.5	415	--	--

1/ Not backflushed

2/ Specific capacity less than the values given. The air line in the well is perforated 9 feet below static water level, and drawdown was greater than 9 feet at a pumping rate of 3,527 gpm.

ineffective backflushing during 1958-61 (table 3). The pump was removed from the well, and a traverse down the well was made with a closed-circuit television probe.

This exploration showed that only the upper 5 to 6 feet of the screen was open and that the lower 14 to 15 feet of screen was lined with the filamentous black flocculant. The screen was cleaned by wire brushing and air agitation. Black flocculant, a small amount of mineral scale, and silt were recovered from the well. Subsequent test pumping of the well at a rate of about 1,000 gpm produced a drawdown of 1.5 feet, or a specific capacity of about 660 gpm per foot of drawdown. After further air agitation and treatment with a polyphosphate sequestering agent, the well was again tested. At a rate of 1,000 gpm the drawdown was 1.0 foot (oral communication, Mr. Foster Gambrell, Layne-New York Company, Inc., Feb. 18, 1963). Subsequently the well was returned to service, but after a few minutes of pumping at an approximate rate of 2,100 gpm the yield dropped to 80 gpm per foot of drawdown (oral communication, Mr. John J. Meehan, Superintendent, Water Department, city of Schenectady, Feb. 20, 1963). This suggests that redevelopment of the aquifer and well by pumping at a lower rate (1,000 gpm or less) did not remove all of the accumulated silt and other fine-grained material in the immediate vicinity of the well and gravel pack. Pumping at the higher rate probably caused a very rapid migration of fine-grained material, some of which may have been loosened by the treatment, to the screen face and resulted in relatively sudden clogging and reduction of yield.

Later in February 1963, the pump was again removed and further treatment applied after testing established that the specific capacity was about 65 gpm per foot of drawdown at a pumping rate of 800 gpm (oral communication, Mr. Foster Gambrell, Layne-New York Company, Inc., Mar. 4, 1963). After wire brushing and air agitation, a specific capacity of 720 gpm per foot was obtained at a pumping rate of 1,000 gpm. The well was then backflushed and treated with Calgon and at a pumping rate of 1,000 gpm the specific capacity increased to 1,000 gpm per foot. The service pump was then installed and tested at 1,350 gpm, but the specific capacity was only 135 gpm per foot of drawdown. The well was subsequently backflushed and pumped nine times through the pump column. This increased the specific capacity to 400 gpm per foot at a pumping rate of 2,204 gpm. This suggests that the velocity of ground water becomes competent to transport large quantities of fine-grained material (silt) at pumping rates in excess of 1,000 gpm.

The evidence suggests that migrating silt slowly accumulates at the bottom of the exterior screen face where entrance velocities and internal well-bore velocities are initially lowest. As individual slots become clogged progressively upward, circulation of water inside the screen below the clogged area decreases and essentially stops. The clogging continues until the wells are backflushed or otherwise treated. Normally this is before the screens become completely clogged. When circulation essentially ceases in the clogged lower part of the screen, deposition of the iron-manganese flocculant probably takes place. It seems unlikely that the flocculant occurs prior to silting because velocities inside of the screen are probably great enough to exceed the adhesive and cohesive properties of the deposit. This concept is supported by the data in table 3 which shows that mild agitation removed much of the flocculant but did not remove the silt and improve the yield.

It must be assumed that the migration of silt will continue. Relief or partial relief of the clogging problem could be achieved in several ways:

1. Reduce the pumping rate of individual wells, hence, the velocity of ground-water movement. It is likely that an optimum rate and velocity could be established by experimental means.

2. A regular program of reconditioning and redevelopment of each well similar to the treatment of well 249-359-80 in 1963, the timing of which might be determined as the point when the yield of a well drops below 1,000 gpm.

3. It is possible that better performance of future wells could be obtained by (a) not gravel packing the well screens but by developing an envelope of graded aquifer materials around the screen, or (b) better and more thorough development of gravel-packed wells. The techniques involved in both methods are the same.

CHARACTER, THICKNESS, AND AREAL EXTENT OF THE AQUIFER

The aquifer consists of a complex sequence of discontinuous coarse sand and sandy gravel deposits which contain a few lenses of medium to coarse, clean, well-sorted gravel and a few thin lenses of silty clay. The sand and gravel lenses are practically devoid of material finer than medium-grained sand. A gravel lens intersected by well 249-359-45 (pl. 2) contained principally gravel averaging 1 inch in diameter. A sample from a gravel lens intersected by well 249-359-57 contained only gravel that was larger than 1 inch in diameter.

The aquifer at the well fields is underlain by glacial till, the surface of which is shown by contour lines in plate 2. An extensive sand unit as much as 30 feet thick separates the coarse sandy gravel unit from the till in much of the well field area. The sand unit is a part of the aquifer but it is undoubtedly of much lower permeability than the sandy gravel unit. The well fields lie approximately across the axis of a trough-shaped depression in the till surface which deepens northeastward toward the river. The top of the aquifer ranges in altitude from 190 to 210 feet. The coarse sandy gravel unit of the aquifer averages about 35 feet in thickness at the Schenectady well field. It grades laterally into sand and thins rather abruptly to the south, east, and west of the Schenectady well field. The sandy gravel unit thickens northeastward to more than 50 feet between the Rotterdam well field and the Mohawk River, and is more than 100 feet thick at Lock 8. The average thickness of the aquifer between Lock 8 and the Rotterdam well field is estimated to be about 100 feet. The surface of the aquifer rises upstream and is at or just below land surface and the river channel in the vicinity of Lock 8. The interrelation and lithology of the deposits in the well field area is shown in plate 3.

The aquifer is bounded on the west by the relatively impermeable till and bedrock of the valley wall. Only an insignificant amount of ground water moves into it from this area. On the south, the aquifer thins abruptly and grades into a deposit of silty sand which is much less permeable than the sandy gravel unit of the aquifer.

The aquifer is overlain by flood-plain deposits of silty sand in most of the area from the well fields north to Lock 8. The thickness of the flood-plain deposits ranges from 30 to 50 feet. These deposits are principally sand and silt which contain minor amounts of clay and gravel. They are moderately permeable and do not represent a tight confining bed over the aquifer. However, their permeability is much less than that of the underlying sandy gravel. The present channel of the Mohawk River is cut through these deposits and into the top of the coarse sand and gravel aquifer.

Simpson (1952, p. 77 and fig. 29) believed that an area of relatively impermeable materials lay between the river and the aquifer from south of the Schenectady well field to near Lock 8. Data collected in the present investigation have generally substantiated his belief, and have better defined the character and thickness of these materials. The river is controlled by low dams for navigation and hydroelectric power purposes, and fine-grained sediments have been deposited on most of the riverbed. These deposits consist of a layer of sand, silt, and clay, as much as 4 feet thick, which contains some organic material. This layer has a relatively low permeability (one sample tested had a coefficient of permeability of 0.06 gpd per square foot), and it acts as a partial barrier to infiltration of river water into the aquifer below. Because of current action in the river during floods, controlled changes of river level, and because of dredging of the river bottom to maintain a navigable depth, the thickness of the riverbed materials and the rate of infiltration may differ from place to place and from time to time.

In the pool below Lock 8 the flood-plain deposits overlying the aquifer thicken downstream. In this reach the river level is held at an altitude of 212 feet except for a period of 1 to 2 months in the winter, when it is lowered by the removal of flashboards from the Vischer Ferry dam. Turbulence due to water flowing over the dam at Lock 8 and ground-water discharge in the channel immediately below Lock 8 prevent the deposition of fine-grained materials in that area. Otherwise, siltation of the riverbed may occur at all altitudes below the controlled level during much of each year when river conditions of sediment load and velocity permit. In the pool above Lock 8, however, the vertical range of river level is much greater and the rate and amount of effective siltation varies considerably over the riverbed.

During the navigation season, pool level behind Lock 8 is controlled at an altitude of 226 feet and short-period fluctuations generally range between 225 and 227 feet. During the non-navigation season this pool level is lowered to an altitude of 213 feet. Thus, below an altitude of 213 feet, siltation may occur in the upper pool all year long whenever river conditions permit. Between 213 and 225 feet siltation may occur about 7 months

per year, and from 225 to 227 feet it may occur only intermittently during 7 months. During the non-navigation season, the materials deposited between altitudes of 213 and 227 feet are exposed to the weather and are subject to erosion and removal. It follows that these deposits are thickest below 213 feet and that their thickness decreases markedly up the river bank.

Permeability and transmissibility of the aquifer

The average coefficient of permeability of the coarse sand and gravel aquifer is estimated to be on the order of 100,000 gpd per square foot, but the permeability of some of the gravel lenses appears to be much greater than the average. All of the production and test wells have been finished in the sandy gravel units of the aquifer, and the following discussions of pump-test data are restricted to that unit. The lower sand unit has not been tested, but is thought to be much less permeable. The average porosity of the deposit is estimated to be between 20 and 30 percent.

Pumping tests have been conducted at the Schenectady well field by the Layne-New York Company, Inc., and by the U.S. Geological Survey. Some of the earlier tests were referred to by Simpson (1952, p. 79). These tests have been difficult to analyze because of the exceptionally high permeability of the aquifer. The coefficient of transmissibility of the aquifer in the well field area was computed from test data (from pumping wells 249-359-77 and -95 in 1959) by several different methods, which produced values in the range from 5 to 15 mgd per foot. This indicates that the coefficient of permeability of the aquifer is in the range from 100,000 to 300,000 gpd per square foot. The area of very high permeability is believed to be restricted to the general area of the Schenectady well field.

The available data suggest that the permeability of the aquifer in the vicinity of the Rotterdam well field may be substantially less than it is in the Schenectady field. A pumping test was conducted in July 1952 upon completion of wells 249-359-92 and -93. These two wells were simultaneously pumped at a rate of about 4 mgd each (2,800 gpm). After 24 hours of pumping, the drawdown was 4 feet in well 249-359-92 and 11 feet in well 249-359-93. The specific capacity of the wells was about 270 and 700 gpd per foot of drawdown, respectively. Drawdown in well 249-359-91, used as an observation well, was only 1 foot. The drawdown was greatest in the well nearest to the thickest part of the aquifer. Table 9 shows that the two pumped wells were essentially identical in construction, depth, and diameter. The driller's logs of the three Rotterdam wells indicate the presence of considerable clay and sand in the upper half of the aquifer, which may account for its lower permeability in this area.

Figures 19 and 20, presented later in this report, are maps of the water table in the well field area. These figures show that the slope of the water table in the vicinity of the pumping wells is relatively flat, and this may reflect the extremely high transmissibility of the sandy gravel.

The yield of the aquifer is dependent upon the infiltration of water from the Mohawk River. The relationship between water levels and water temperatures in the river and the aquifer must be examined and considered

before the yield of the aquifer can be evaluated. Although water levels and water temperatures in the river and in the aquifer are discussed separately in the following sections for clarity and understanding, their interrelationship and effects are very complex.

RELATIONSHIP BETWEEN RIVER LEVEL AND GROUND-WATER LEVEL

Because of the high transmissibility of the aquifer, it may be assumed that the natural static water level in the aquifer, in the vicinity of the well fields, is at the same level as the Mohawk River. The daily highest water level of the Mohawk River and in well 249-359-58, and the pumping rate of the two well fields for the year ending July 31, 1961, are shown in figure 12. The altitude 1/ of river level was measured downstream from Lock 8, at the old General Electric Company river-water pumping station, immediately north of well 249-359-69. (See plate 2.) Well 249-359-58 is located near the center of the Schenectady well field. The fact that the water levels in the river and in the well rise and fall more or less in direct phase with one another is apparent.

It is less apparent, because of the construction requirements of the graph, that there is also a close relationship of water-level fluctuation in the aquifer and the rate of pumping. The relationship in this case, however, is inverse; the water level declines when the pumping rate increases and rises when the pumping rate decreases. The minor day-to-day fluctuations of water level in the aquifer are in response to pumping, to changes in river level, and to changes in pumping rate. The longer term fluctuations of the water level in the aquifer (monthly, seasonal, annual) are mostly the result of seasonal changes in river level and in the temperature of water in both the river and the aquifer.

The difference between river and aquifer water levels at a given time represents the head of water necessary to infiltrate water from the river into the aquifer and to move it through the aquifer to the wells being pumped. The difference between the water level in the well and that of the river changes in response to several factors including (1) changes in the temperature of water both in the river and in the aquifer, (2) changes in river level in both the upper and lower pools at Lock 8, (3) floods, (4) the rate of pumping at the well fields, and (5) local recharge by rainfall and snowmelt.

Inspection of figure 12 shows that during the month of August the difference between water levels in the river and the aquifer was relatively constant and was the least of any period of the year. From the end of August until the end of the navigation season the difference between the

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1/ Altitudes shown in figure 12 and other illustrations are referred to the city of Schenectady datum which is 0.26 feet above the mean sea level datum of the U.S. Geological Survey. Please refer to the section of this report entitled "Division of Work and Acknowledgments."

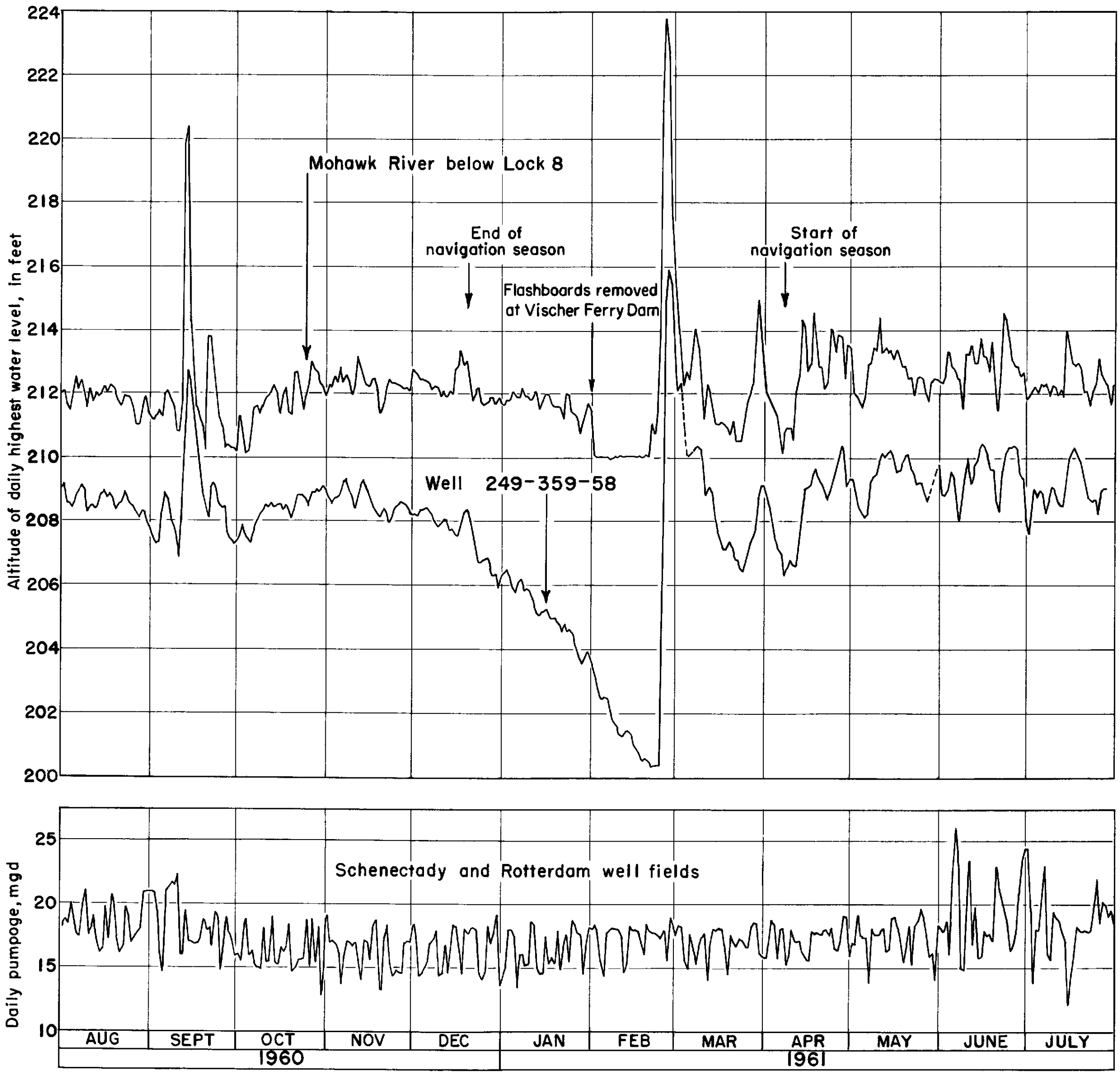


Figure 12.--Hydrograph of the water levels in the Mohawk River and in well 249-359-58, and the pumping rate at the well fields for the year ending July 31, 1961.

water levels slowly increased as a result of seasonal lowering of both river and ground-water temperature, which decreased the coefficients of permeability of the riverbed deposits and the aquifer.

About the middle of December 1960, the water level in the aquifer began to decline at a greater rate than previously, and continued to do so for a period of about 6 days after which the rate decreased. The start of the rapid decline correlates with the end of the navigation season, at which time the dam at Lock 8 was removed and the upper pool level was lowered 13 feet. This is shown diagrammatically in figure 13, as the change from

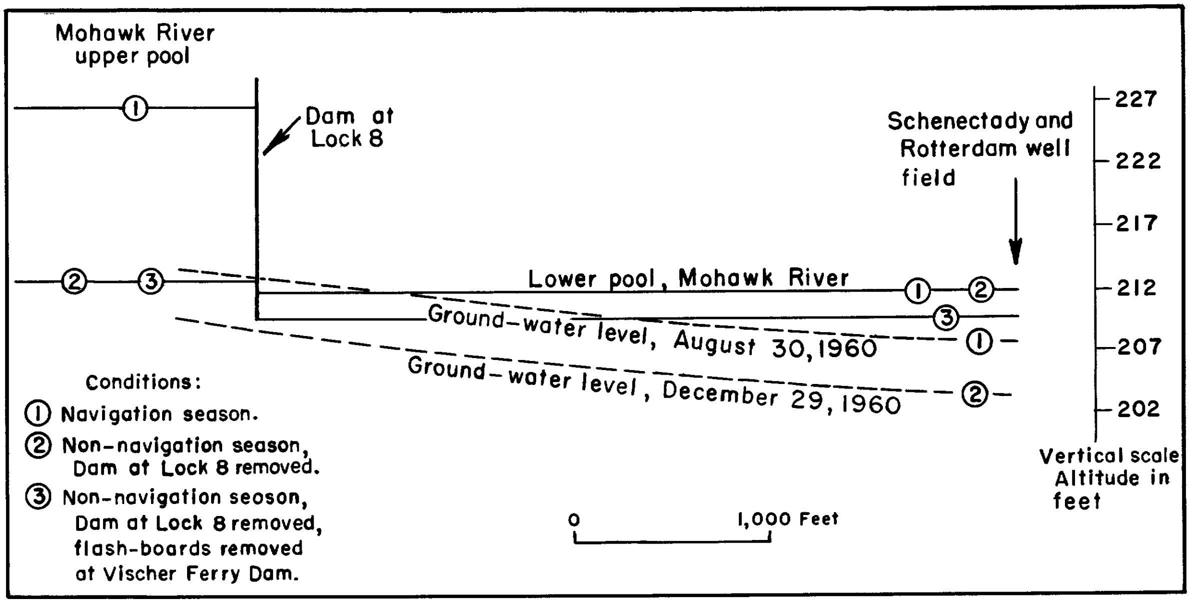


Figure 13.--Diagram showing the relationship of controlled seasonal changes of Mohawk River level, and showing profiles of water levels in the aquifer at times during both the navigation and non-navigation season.

condition (1) to condition (2). At about this same time, river temperature had reached 32°F and brought the coefficient of permeability of the riverbed materials to its lowest value of the year. These factors greatly reduced the amount of infiltration from the river to the aquifer above Lock 8. As a result, with continued pumping, the water level in the aquifer declined as water was withdrawn from storage in the aquifer, and the cone of depression expanded and deepened.

Early in February 1961, the flashboards on the dam at Lock 7 were removed and the lower pool of the Mohawk River at Lock 8 was lowered about 2 feet to an altitude of 210 feet (condition 3, fig. 13). This lowered the water level in the aquifer about 2 feet in the 12-day period which began on January 31, 1961 (fig. 12). By February 11, 1961, the rate of decline again decreased and returned to the previous slower rate. The water level in well 249-359-58 reached an altitude of about 200 feet just before the flood of February 23, 1961. This flood (fig. 12) replenished storage in the aquifer and the water level in the aquifer rose to an altitude of nearly 216 feet before starting to decline again. Periods of high water on the Mohawk River were at sufficiently frequent intervals between the end of February and mid-April, and river temperatures remained above 32°F, so that the water levels in the aquifer did not decline again to the low level of February 23. After the dam at Lock 8 was reinstalled in mid-April 1961, the water level in the aquifer (well 249-359-58) returned to the usual range of levels that exist during the navigation season because of higher river levels, and change in the location of the infiltration area.

From the beginning of the navigation season until about August 1, the difference between the water levels decreases due to increasing river water temperatures.

In the non-navigation season of 1961-62 (not illustrated) a thaw and flood in January prevented water levels in the aquifer from declining below an altitude of about 203.5 feet. In March 1963, however, the water level in the aquifer reached an altitude of about 197.5 feet, which was the lowest water level observed in the aquifer to that time. This is shown in figure 14 which includes the hydrographs of well 249-359-58, and the Mohawk River below Lock 8, and the combined pumpage of the two well fields during the period November 1962 through July 1963. The effect of removing the dam at Lock 8 and the removal of the flashboards at Lock 7 is clearly indicated in figure 14. Note that each of these two changes in stream regimen caused rapid declines of the water level in the aquifer similar to those which were observed during 1960-61 (fig. 12). The relationships are much better defined in 1962-63 because of very uniform pumping rates and river level, in fact, the most uniform for the longest period ever observed through that time. Pumping rates for the 1962-63 season averaged slightly over 16 mgd. After adjusting to the change in river level (fig. 14), the rate of decline of ground-water level is reduced slightly but is greater than before the dam was removed. Because the pumping rate is essentially constant, the more rapid decline indicates that the rate of infiltration has become less than the pumping rate. The removal of the flashboards from the dam at Vischer Ferry lowers river level 2 feet below Lock 8 and causes a nearly identical amount of change in the aquifer water level. This, and the fact that the rate of decline of water levels in the aquifer after adjusting to this change in river level is the same as the rate of decline immediately prior to removal of the flashboards, show that the net effect of the flashboards is a direct change in head and storage relationship with the aquifer which does not change the rate of infiltration of river water. The fact that the subsequent decline of water levels remains essentially a straight line (fig. 14) until the flood in March 1963 indicates that pumpage exceeded the amount of infiltration throughout that season. The relationships described here are shown diagrammatically and are summarized in figure 15.

The data in figures 12 and 14 show that water level in the aquifer reached a much lower level, at a lower pumping rate, in 1963 than in 1961. One of the reasons for this is that there was no appreciable fluctuation of river level up into the zone of thin riverbed deposits during the non-navigation season in 1962-63. Hence, there was insufficient infiltration and no replacement of ground-water storage in the aquifer until, and in the manner of, the floods shown in figures 12 and 14.

Effect of floods on recharge

Figure 14 shows that river levels were very stable from the time Lock 8 was removed early in December 1962, until the flood that occurred with the spring thaw, late in March 1963. This was also true in the 1960-61 season, but for a shorter period of time. However, during the 1961-62 season, and many others as well, the river level rose substantially

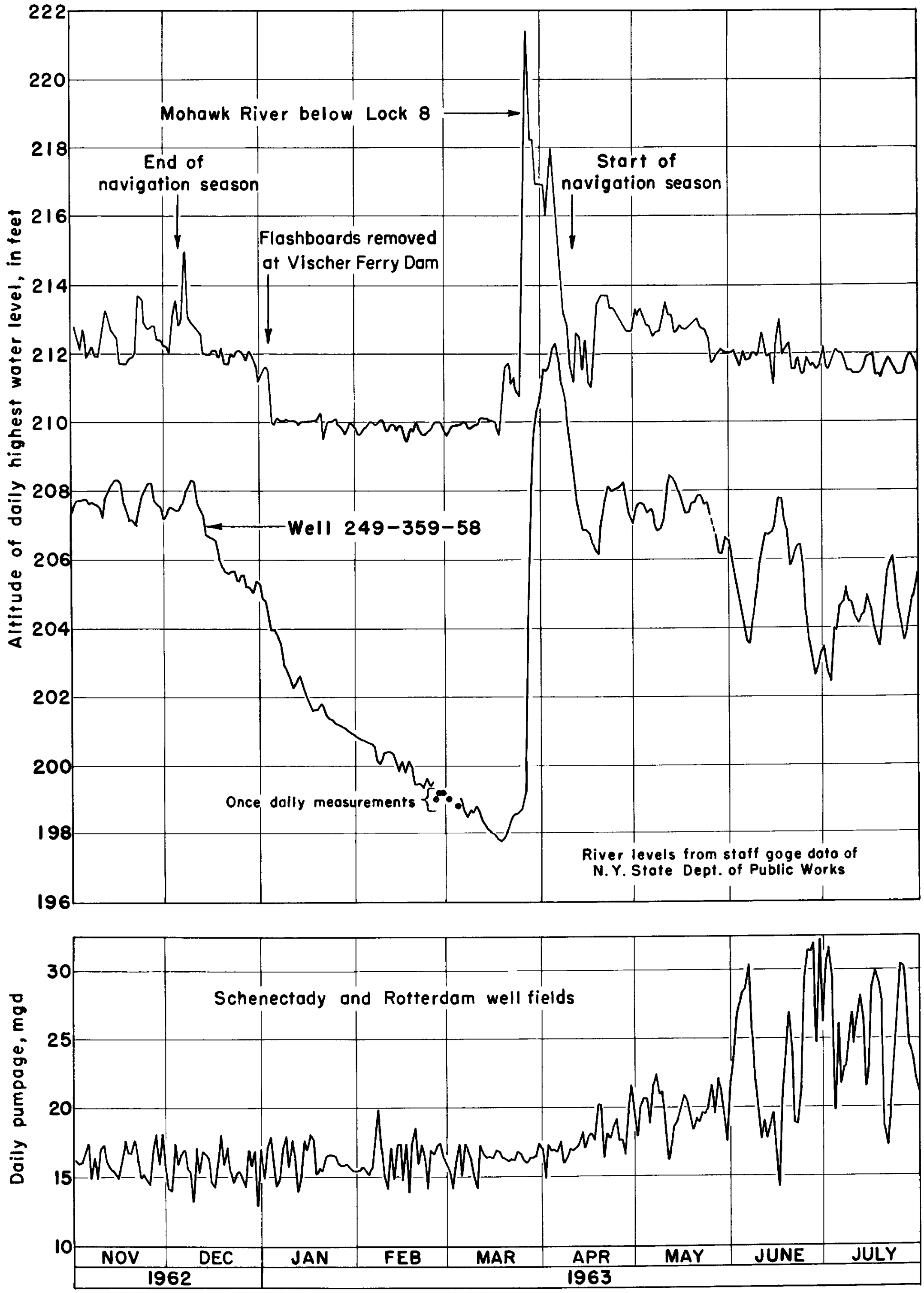
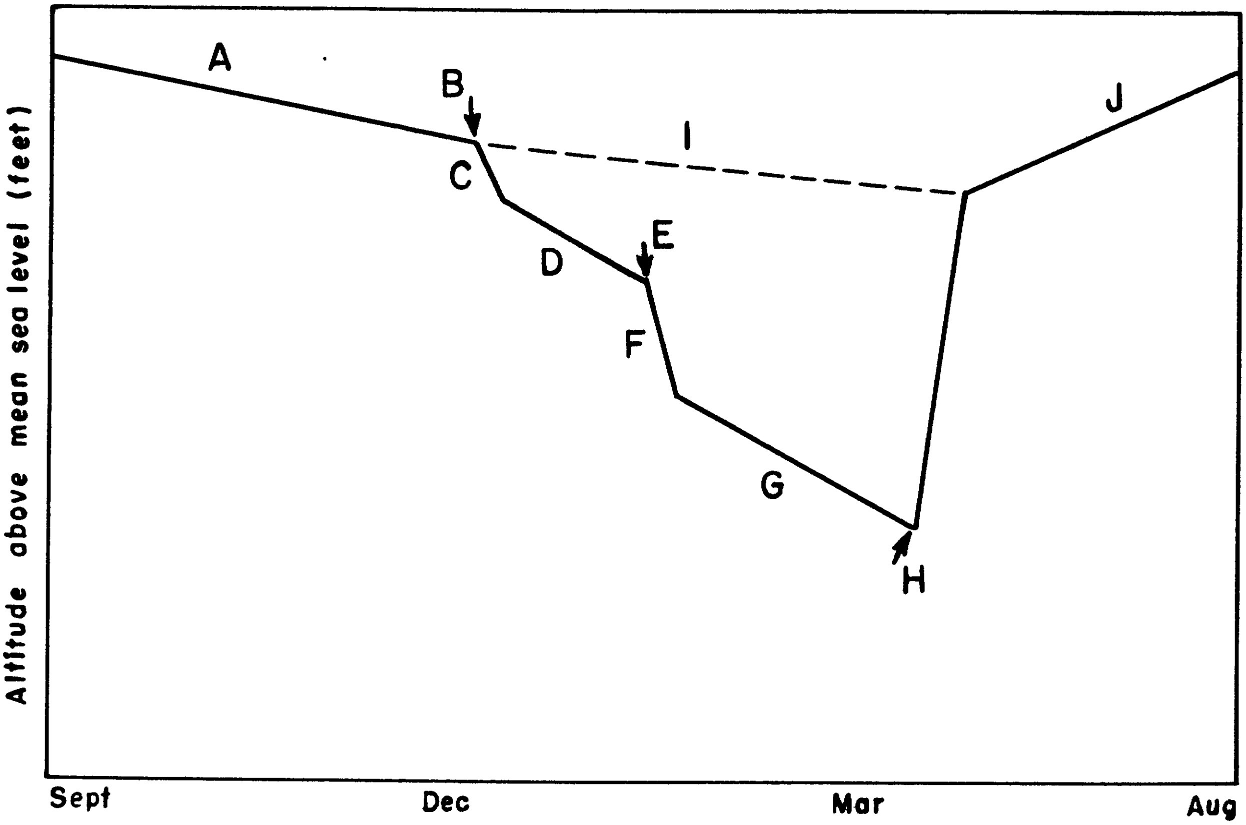


Figure 14.--Hydrograph of the water levels in the Mohawk River and in well 249-359-58, and the pumping rate at the well fields during the period November 1962 through July 1963.



A - Decline in water level resulting from seasonal decline in river and ground-water temperatures.

B - Dam at Lock 8 removed.

C - Decline resulting from change in area of principal recharge from the pool above Lock 8, to immediately downstream from Lock 8.

D - Decline resulting from inability of winter recharge area (below Lock 8) to supply pumpage. Part of pumpage being derived from storage.

E - Flashboards removed from Vischer Ferry (Lock 7) dam.

F - Decline resulting from lowering level in Vischer Ferry pool.

G - Decline resulting from inability of winter recharge area (below Lock 8) to supply pumpage. Part of pumpage being derived from storage.

H - Installation of dam at Lock 8.

I - Predicted decline of water level if Lock 8 dam and Lock 7 flashboards were not removed. Reflects cooling of water in the aquifer.

J - Rise resulting from seasonal warming of water in river and aquifer.

Figure 15.--Diagrammatic hydrograph of water level in the aquifer during a non-navigation season in which recharge from the river did not occur.

one or more times during the non-navigation season and resulted in considerable recharge to the aquifer. The water level in the aquifer during such a season is shown diagrammatically in figure 16.

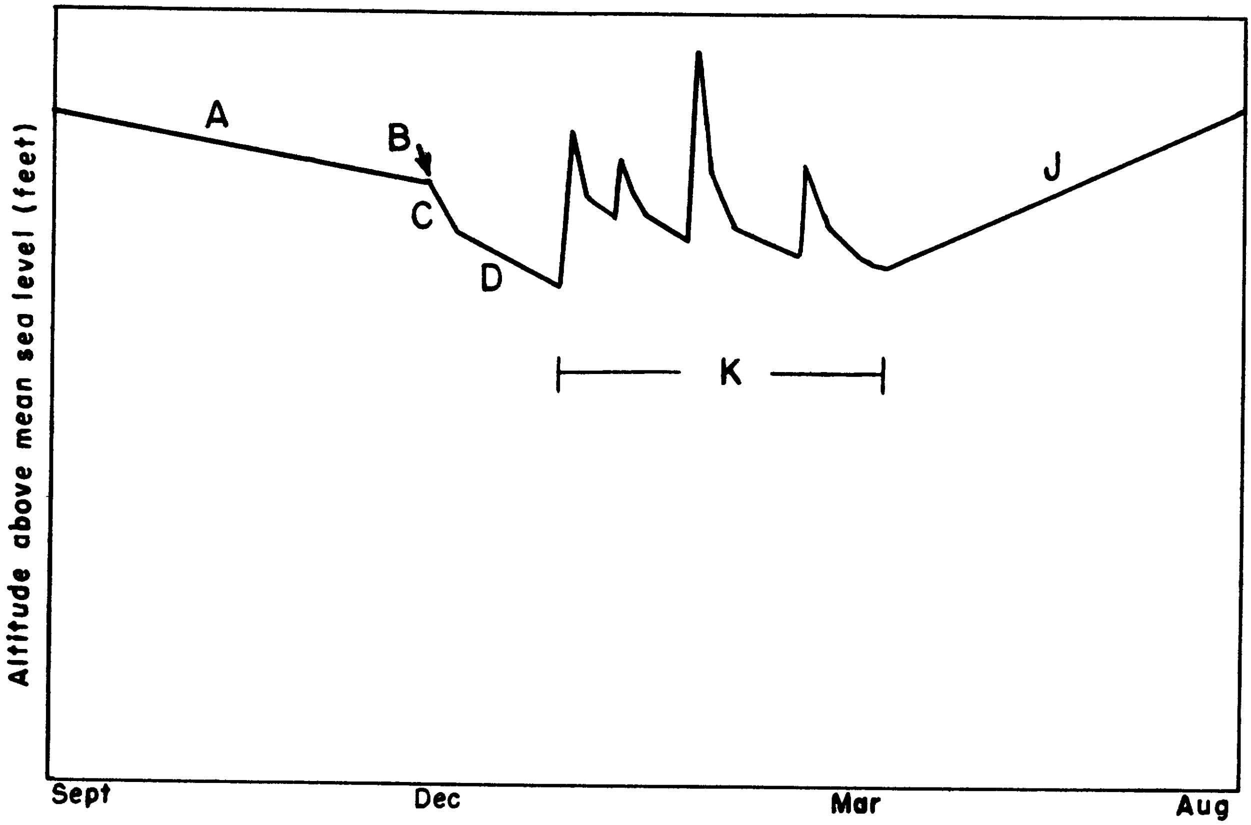
At pumping rates that are substantially higher than those in 1962-63, and which would result in a greater drawdown of water levels in the aquifer, prolonged conditions of low water level in the river severely limit the yield of the aquifer during the winter seasons. Table 4 shows that river conditions similar to those shown in figure 14 (no recharge in January and February) occurred in a total of 8 winter seasons, or an average of once every 6 years for the 46 seasons of river record. In 3 of these 8 seasons, or once every 15 years, there was no high discharge, and hence, no significant replacement of storage in the aquifer from before mid-December until late March (1930-31, 1939-40, 1962-63).

Table 4 is based on a good correlation of periods of high discharge in the Mohawk River and observed winter recharge in the aquifer during the period 1946-63, and on periods of similar high discharge in the river for the period 1917-46. The following paragraphs discuss the effect of floods on the aquifer in greater detail.

In figure 12 the periods of high water on the river in September 1960 and February 1961, were accompanied by substantial rises of water levels in the aquifer. River level did not reach the top of the riverbank in the vicinity of the well fields during either of these floods. During floods the flashboards on the dam at Lock 7 are removed and after a flood river level is usually permitted to drop to an altitude of about 210 feet before the flashboards are reinstalled.

Between 10 a.m., February 23, 1961, and 10 a.m., February 26, 1961, the level of the Mohawk River rose about 14 feet. The water level in well 249-359-58 did not start rising until about 8 p.m., February 24, but by 9 a.m., February 27, the water level had risen about 15 1/2 feet, or nearly 6 feet above the preflood river level and 1 1/2 feet more than the river rose. On September 13, 1960, when the flood crested on the river at an altitude of 220.42 feet at 4 a.m., the water level in well 249-359-58 was at an altitude of 210.90 feet and rising at a rate of 0.65 foot per hour. On February 26, 1961, when the flood crested on the river at an altitude of 223.67 feet at 10 a.m., the water level in the well was at an altitude of 209.55 feet and was rising at a rate of 0.9 foot per hour. At the times the river crested, the difference between river and ground-water levels was about 9 1/2 feet for the September flood and slightly more than 14 feet for the February flood, as compared with a difference of about 4 feet and 9 1/2 feet, respectively, before the river started to rise.

After the floods the water level in well 249-359-58 declined at a rate sufficiently fast so that it maintained a position below river level. However, the peak water level in well 249-359-58 was not reached until after the flood crest on the river during these floods. Thus, for a period after the flood crests, river level was declining and ground-water level at the Schenectady well field was still rising. During these periods the hydraulic gradient between the river and the well field became progressively smaller



A - Decline in water level resulting from seasonal decline in river and ground-water temperatures.

B - Dam at Lock 8 removed.

C - Decline resulting from change in area of principal recharge from the pool above Lock 8, to immediately downstream from Lock 8.

D - Decline resulting from inability of winter recharge area (below Lock 8) to supply pumpage. Part of pumpage being derived from storage.

J - Rise resulting from seasonal warming of water in river and aquifer.

K - Changes in water level resulting from floods on Mohawk River caused by ice jams or high streamflow. Note that the effect of removal of the flashboards at Vischer Ferry dam may be completely obscured by recharge.

Figure 16.--Diagrammatic hydrograph of water level in the aquifer during a non-navigation season in which there was recharge from the river.

Table 4.--Months of the non-navigation season in which the aquifer was recharged, as inferred from periods of high discharge in the Mohawk River and water-level fluctuations in the aquifer

Non-navigation season	December (15-31)	January	February	March
1917-18			X	
1918-19	X			X
1919-20				X
1920-21		X	X	X
1921-22			X	X
1922-23		X		X
1923-24		X		X
1924-25			X	X
1925-26		X		X
1926-27		X	X	X
1927-28		X	X	X
1928-29		X		X
1929-30	X	X	X	X
1930-31				X
1931-32		X	X	X
1932-33	X	X		X
1933-34		X		X
1934-35		X	X	X
1935-36				X
1936-37	X	X	X	X
1937-38		X	X	X
1938-39		X	X	X
1939-40				X
1940-41	X		X	X
1941-42	X			X
1942-43	X		X	X
1943-44		X		X
1944-45		X	X	X
1945-46		X	X	X
1946-47		X		X
1947-48			X	X
1948-49	X	X	X	X
1949-50		X	X	X
1950-51		X	X	X
1951-52	X	X	X	X
1952-53		X	X	X
1953-54		X	X	X
1954-55	X		X	X
1955-56		X		X
1956-57		X	X	X
1957-58	X			X
1958-59		X		X
1959-60		X	X	X
1960-61			X	X
1961-62		X		X
1962-63				X

Records:
Well 249-359-98, April 1946-March 1961
Well 249-359-58, June 1960-April 1963
Mohawk River at Cohoes, N. Y., (Albany County) December 1917-April 1963

and locally the hydraulic gradient was reversed so that some of the water previously infiltrated was discharged back to the river. This was also shown by water levels in wells near the river's edge which were above river level at times during the flood recession periods.

Infiltration from the river to the aquifer increases greatly during rising flood stages because of the (1) greatly increased hydraulic gradient between river and aquifer, (2) significant increase in infiltration area as additional and higher parts of the river channel and banks are submerged, and (3) higher permeability of the newly flooded areas as compared with the permeability of the riverbed materials below normal river levels, both above and below Lock 8.

Figure 17 shows the changes of water level in the Mohawk River and in several wells in the aquifer in response to the flood of September 1960 (well locations are shown in plate 2). The time lag between the flood crest on the river and the peak water levels in the observation wells increases with the distance between the river and the wells. It reflects the time necessary for the effect of the decline in river level to reach the wells and thus reverse the rising trend. The time lag for any of these wells is governed by the length of the ground-water flow path between the well and the point of infiltration from the river, the transmissbility of the aquifer and the riverbed materials and the hydraulic gradient along the flow path.

In figure 18, the altitude of water level in the Mohawk River is plotted against the water level in well 249-359-8 for given times during the flood which began on January 3, 1960. The well is located about 800 feet from the river. The flood was caused by an ice jam in the Mohawk River below the well fields. The flood crest on the river occurred at noon, January 4, about 24 hours after the initial rise of river level. An additional 24 hours elapsed before the highest water level in the well was attained. Both river level and water level in the well declined slowly from noon on January 5 until January 14 when normal low-pool conditions on the river and water levels in the aquifer were reached.

Figures 17 and 18 show that the lag time of peak water levels in well 249-359-8 was twice as much in the January flood as in the September flood. This occurred because water temperatures and viscosity in the river and aquifer in January were at seasonal low levels, hence, permeabilities of riverbed materials and the aquifer were similarly low and the velocity of water was, therefore, slower than in September when the temperature factors were essentially the opposite.

The diagonal line in figure 18 is drawn through points of equal altitude for the two scales. Largely because of pumping in the aquifer and the location of well 249-359-8 with respect to the center of pumping and the river, the water level in the well remained below river level during the entire period of the flood. The relationship shown in figure 18 reflects the distance of the well from the river, the transmissibility of the aquifer and riverbed materials, the coefficient of storage, and the hydraulic gradient between the well and the area of infiltration from the

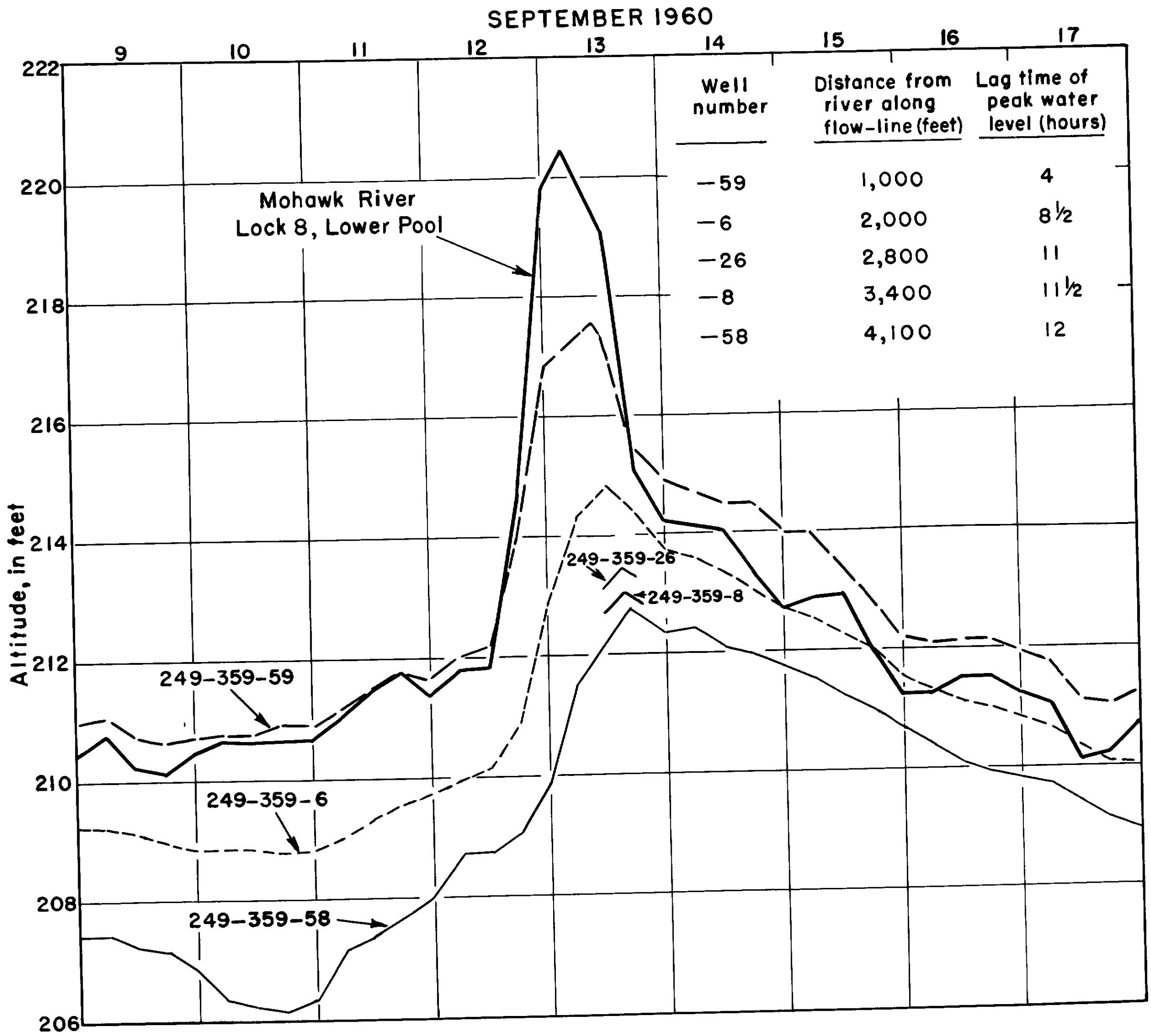


Figure 17.--Changes of water levels in the aquifer and in the Mohawk River during the flood of September 1960.

river. For a well close to the area of infiltration from the river, the graph would lie above the diagonal line during the rise of river stage, when water was moving into the aquifer, and lie below the diagonal line as the flood receded, when water moves from the aquifer back into the river.

Configuration of the water table in the vicinity of the well fields

Figures 19 and 20 show contours on the water table in the vicinity of the well fields on August 3 and December 29, 1960, during the navigation and non-navigation seasons, respectively. The data for these maps were collected by measuring water levels in each of the wells two times, about

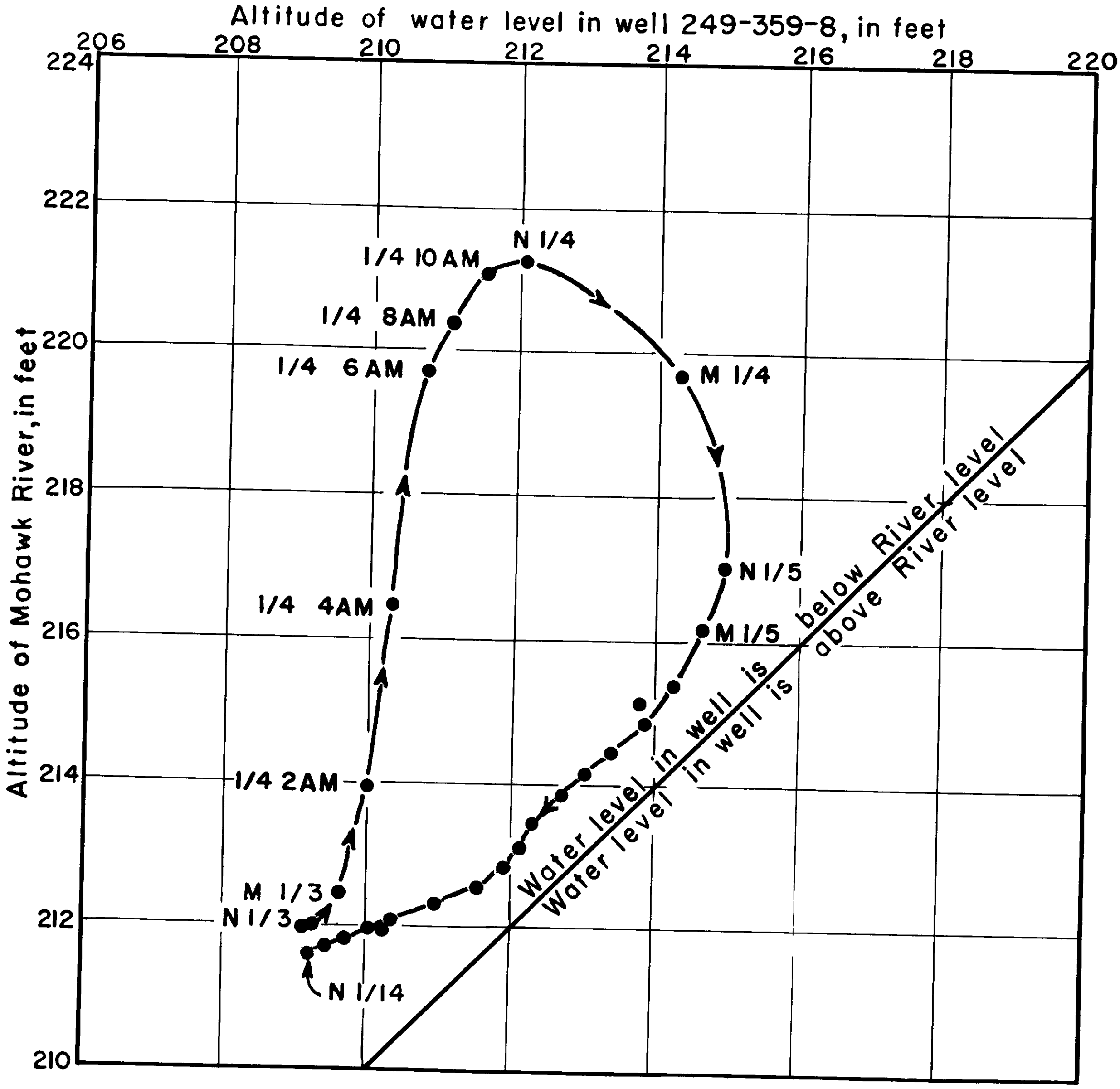


Figure 18.--Graph showing relationship between rise in level of the Mohawk River and the water level in well 249-359-8 during the flood beginning January 3, 1960. (Abbreviations: N, noon; M, midnight; AM, morning; 1/4, January 4.)

an hour apart, on each of the two dates. All of the measurements on each of the two days were made within a two-hour period. Pumping rates at the well fields and water levels in the aquifer and the river were essentially constant during the periods of measurement and for the preceding 12 hours. The city of Schenectady was pumping at a constant rate of 18.28 mgd on August 3, and at a rate of 15.30 mgd on December 29 until the water-level measurements were completed. The town of Rotterdam wells were not pumped

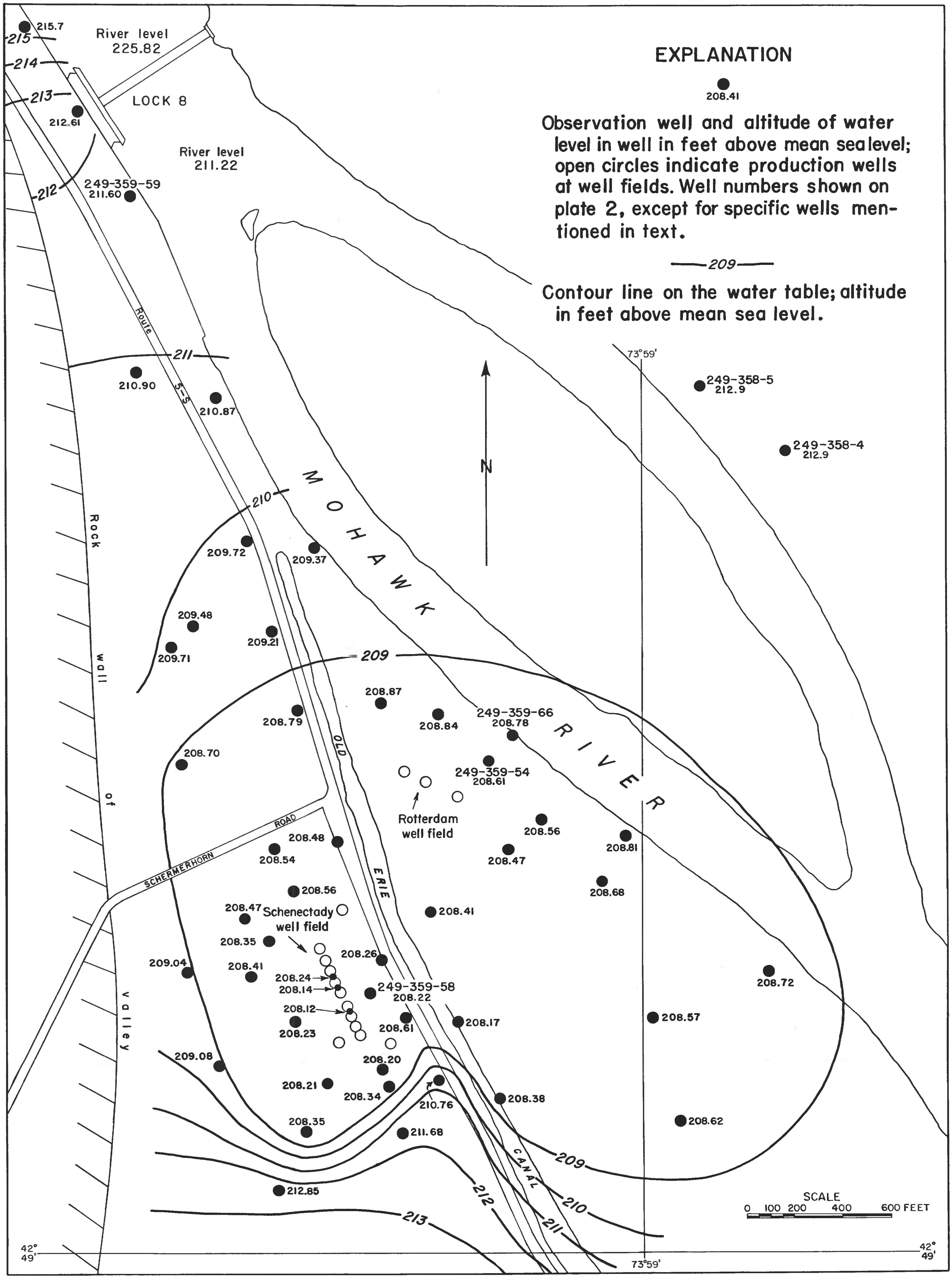


Figure 19.--Map showing configuration of the water table in the vicinity of the well fields during the navigation season on the Mohawk River on August 3, 1960.

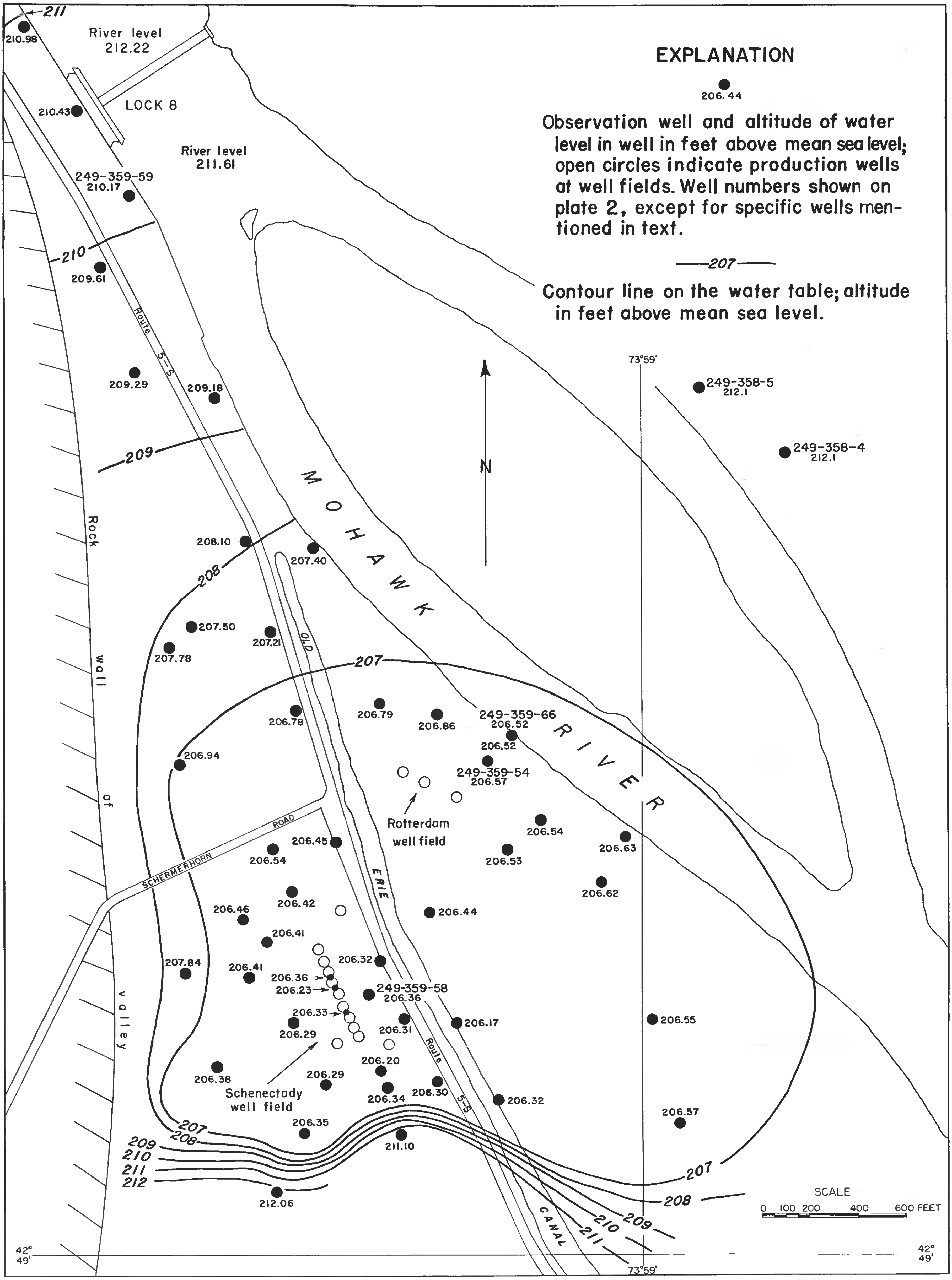


Figure 20.--Map showing configuration of the water table in the vicinity of the well fields during the non-navigation season on the Mohawk River on December 29, 1960.

on these days until after the water-level measurements were completed. Thus, it was possible to map the water table in the vicinity of the well fields during periods of essentially stabilized conditions. Figures 19 and 20 show that the configuration of the water table at both times was similar and that the water table was about 2 feet lower in December than in August. The ground-water level at the river edge adjacent to the well field (well 249-359-66) was about 2 1/2 feet lower than river level on August 3, 1960, and about 5 feet lower on December 29, 1960.

On both maps the water table around the well fields is very flat. This suggests that the permeability of the aquifer is extremely high, and that very little hydraulic gradient is required to move water through this part of the aquifer. However, it may also indicate that relatively little water is moving through this part of the aquifer, and that almost no water is infiltrating from the river immediately adjacent to the well fields. Temperature data presented later in this report tend to support this second possibility.

On both maps the steep gradient, shown by closely spaced contours south of the well fields, reflects the decrease in permeability where the sandy gravel unit of the aquifer grades into less permeable sand deposits. In the navigation season (fig. 19) the steep gradient immediately above Lock 8 reflects the movement of water through the aquifer, around the dam and lock, under the steep hydraulic gradient represented by the difference in river level on opposite sides of the structure. The gradient is greatly reduced immediately below the dam where the water spreads out and is flowing through a greater cross-sectional area of the aquifer. In December, when the dam at Lock 8 is removed, the difference in river levels across the sill of the dam is only 1 foot and the gradient in the aquifer is greatly reduced.

Both figures 19 and 20 show, by the water levels in wells 249-358-4 and -5, that the cone of depression around the well fields did not extend across the river at the time those measurements were made. However, the cone of depression will extend across the river and divert some ground water from the Scotia area into the well fields during periods of very low water levels in the aquifer which may occur late in the non-navigation season. For example, just before the flood in late February 1961 (fig. 12), river level was at an altitude of about 210 feet, and the water level in well 249-359-54, about 150 feet from the river's edge, was at an altitude of about 200.5 feet. At the same time the water level in well 249-358-5, on the Scotia side of the river (figs. 19 and 20) was at an altitude of about 208 feet, or about 2 feet below river level. The hydraulic gradient at that time suggests the movement of water from the Scotia side of the river into the well field. Ground-water temperature data presented later in this report will show that such movement did occur.

Winter melting of snow or ice jams on the Mohawk River, resulting in periods of high river level, are relatively common and they cause considerable recharge to the aquifer nearly every year. Under such conditions, water levels in the aquifer do not usually decline below an altitude of 205 feet at the 1962 rates of pumping, and the cone of depression usually does not extend across the river. During the winters of 1960-61 and 1962-63 such flooding did not occur until February and March, respectively.

During the navigation season, the cone of depression around the well field is smaller and does not extend across the river at pumping rates of 16-18 mgd. This is because the rate of infiltration of river water is high enough to prevent significant withdrawal of water from storage in the aquifer. If the pumping rate at the well fields were increased several fold, the cone of depression would be much deeper than at present. At such time, the cone of depression would reach more frequently into the area across the river during the non-navigation season. It seems unlikely that the cone would reach across the river during the navigation season except during long periods of very stable, low, river levels and at pumping rates much greater than 16-18 mgd.

AREAS OF STREAM INFILTRATION

Stream infiltration occurs along the river channel wherever the water level in the aquifer is below the level of the river. However, the rate of infiltration is vastly greater in some areas than in others because of differences in the permeability and thickness of the riverbed materials, and in the vertical hydraulic gradient between the river and the aquifer. The available data strongly suggest that over much of the riverbed, the permeability and hydraulic gradient are too low to permit significant amounts of infiltration to the aquifer. Dredging of the river to maintain a navigable depth, the scouring action of the river at different places in time of flood, and erosion of exposed channel banks during the winter thins the layer of low permeability materials on the riverbed, and locally permits greater infiltration. Hydraulic dredging is especially effective because of its efficiency in removing the fine-grained materials.

The dam at Lock 8 has a pronounced effect in determining the principal areas of infiltration. Simpson (1952, p. 35, 72, and 74) on the basis of meager data correctly inferred that most of the infiltration occurred upstream from the well fields. He further emphasized (Simpson, 1952, p. 77-78, and fig. 29) that the principal area of infiltration was immediately upstream and downstream from Lock 8. The present study has shown that although Simpson was generally correct, there are a number of important factors which affect the local rate and area of infiltration seasonally along the entire reach of the river from above Lock 8 to below the well field. As previously mentioned, in the pool above Lock 8 the low-permeability silts and clays deposited on the riverbed are thickest below 213 feet and thinnest in the summer zone of river fluctuations above the altitude of about 225 feet. Below Lock 8 the flood-plain deposits overlying the aquifer are thicker, and low-permeability silts and clays may be deposited on most of the riverbed nearly all year whenever river conditions of sediment load and velocity permit. As a result there is little infiltration to the aquifer along most of this reach of the river.

During the navigation season the 14-foot difference between pool levels above and below the dam and the relatively thin silt and clay deposits on the higher part of the river channel permits the infiltration of a considerable amount of water into the aquifer immediately above the dam. Much of this water moves through the aquifer, beneath and around the

ends of the dam, and on to the well fields. The water in excess of storage and pumping requirements is discharged back into the river just below the dam. This is indicated by the fact that ground-water levels immediately below the dam (well 249-359-59, fig. 19) are above river level during the navigation season. If part of the water was not intercepted by the cone of depression around the well fields, all of this water would re-enter the river below the dam.

When the dam is removed at the end of the navigation season the altitude of the upper pool is lowered to 213 feet, and only about a foot of difference exists between the pool levels above and below Lock 8. The infiltration to the aquifer above the dam is thus essentially stopped because of the great reduction in hydraulic gradient and the relatively thick riverbed deposits below that altitude. When the dam at Lock 8 is removed, the water level in the aquifer immediately below the dam falls below river level, reversing the hydraulic gradient, and a large amount of water begins to infiltrate to the aquifer in this area. Turbulence in the river caused by water flowing over the dam during the navigation season, and the concurrent upward discharge of water through the riverbed, tend to prevent the accumulation of fine-grained materials on a relatively small area of the riverbed immediately below the dam. Therefore, infiltration to the aquifer can occur more readily there during the non-navigation season than it can in any other area of the river bottom within the cone of depression around the well fields.

With this change in river levels the cone of depression about the well fields expands and increases the area of infiltration in order to maintain the total volume of infiltration required by the continuing pumpage. The cone of depression expands through the aquifer, mostly to the north and east, because little additional water can be induced across the relatively impermeable aquifer boundaries to the west and south of the well fields. Figure 13 indicates that the cone of depression may expand more than 1,000 feet upstream from Lock 8 and may reach the aquifer boundaries very quickly.

Data presented earlier show that, during the non-navigation seasons in 1960-61 and 1962-63, the combined effect of the rate of infiltration below the dam, the ground-water inflow from the Scotia area, and the increase of infiltration area due to expansion of the cone of depression did not provide enough water to equal the pumping rate and that the difference was taken from storage in the aquifer.

GROUND-WATER TEMPERATURE

By definition, the coefficient of permeability is standardized at a water temperature of 60°F. However, river temperature in the well field area ranges from nearly 80°F to 32°F annually, and water at 32°F is nearly twice as viscous as it is at 80°F. Therefore, the coefficient of permeability of a water-bearing unit when the water is at 32°F is about half as much as when it is at 80°F. The coefficient of permeability of the silt and clay on the riverbed is very low at water temperatures of 60°F, and it is reduced during the winter by changes in the viscosity of river water. The

coefficient of permeability of the aquifer is exceptionally high, and although it is also reduced by changes of the viscosity of water in the aquifer, the permeability is still very high after the reduction. The effect of decreased permeability of the aquifer, therefore, has less impact on the yield of the aquifer than does the decreased permeability of the riverbed material, for the latter unit regulates the amount of river infiltration. Nearly twice the hydraulic gradient is required to infiltrate a given amount of river water at 32°F through the riverbed materials as is required at 80°F.

The temperature of both the surface-water source and the infiltrated ground water is important in the study of infiltration supplies because (1) the temperature of surface water varies through a wide annual range, and (2) the permeability of a water-bearing unit is affected by the viscosity of water which changes with water temperature. It is the seasonal change in coefficient of permeability of the riverbed materials which is responsible for the previously noted annual cycle of changes in vertical distance between river level and water level in the aquifer during the navigation season. During this investigation ground-water temperatures were measured periodically in most of the observation wells in the vicinity of the Schenectady and Rotterdam well fields. The temperature of water from all the producing wells was also measured.

The temperature of water from the production wells was measured with a mercury thermometer at a tap on the pump discharge. The measurements of water temperature in the observation wells were made at 5-foot intervals by lowering a thermistor probe into the wells. The observation wells were drilled for measurement of water levels in the aquifer, and most of them penetrated only the upper 10 to 15 feet of the saturated part of the aquifer. Hence, little information is available about water temperatures at depth in the aquifer. However, the data collected from observation wells together with the temperature measurements of water pumped from production wells furnish much useful information.

Interpretation of the ground-water temperature data is based on the following premises: (1) under natural conditions the average temperature of ground water (not associated with infiltration from surface-water bodies) approximates the mean annual air temperature, (2) the temperature of ground water in natural transit from a point of recharge to a point of discharge has small annual variation, and (3) river-water temperature approximates the weekly average air temperature except when the air temperature is below 32°F.

Collins (1925, p. 97-98) summarizes the data of earlier workers and states that, for practical purposes, the temperature of ground water at depths of 20 to 200 feet will range from 3°F to 6°F above the mean annual air temperature of the area. He indicates that below depths of 20 to 30 feet the annual fluctuation of temperature is only a degree or two. During the present investigation the temperature of ground-water supplies not associated with stream infiltration ranged from 49°F to 54°F. Although specific data are scant, these measurements support the concept of slight annual fluctuation. An example of the small range of fluctuation of ground-water temperatures is shown by the data from well 249-359-21 in figure 24.

Collins (1925, p. 99) also summarizes the data of earlier workers with regard to the temperature of river water and states that the mean monthly water temperature is generally within 3°F above or below the mean monthly air temperature (above 32°F). The temperature of the Mohawk River was shown by Simpson (1952, fig. 26) generally to be within a few degrees of the 5-day running average of air temperature at Schenectady. The same relationship between air and river temperatures was observed during the present investigation.

Areal variation of ground-water temperatures

The maximum, minimum, and the annual range of temperature of water pumped from production wells at the Schenectady and Rotterdam well fields for the year ending July 31, 1961, are shown in the table below. The data presented in this table show large annual ranges of ground-water temperature in the well fields. In some instances, the range is about one-half that of the Mohawk River. The effect of infiltration of river water to the aquifer is, thus, clearly established.

Figure 21 shows the temperature of water in the aquifer at different times during 1960-61, by means of contours that connect points of equal ground-water temperature. The movement of water from the river through the aquifer causes the shifting of contours from one period to the next. The general pattern and position of the contours shown in figure 21 will remain about the same from year to year. However, it will vary in detail because of the following factors: (1) variation in the annual range of river temperature, (2) variation in the amount of water pumped at the well fields, and the distribution of pumping between the various wells, (3) changes in river level due to operation of navigation dams, and (4) dredging of the river which removes or reduces the thickness of the fine-grained riverbed materials and increases the infiltration rate in the dredged area. Thus, the direction and rate of ground-water movement and the pattern of ground-water temperatures in any part of the aquifer will change with variation of any of these conditions.

Figure 21 shows that in the fall river temperatures become progressively colder and in the spring they become progressively warmer. Thus, two times a year the temperature gradient between the river and the aquifer is reversed. As a result, distinct masses of warm water exist in the aquifer during the winter months and masses of cold water exist during the summer months. These "seasonal masses" of water in the aquifer are most persistent in areas where the rate of ground-water movement is slowest. As the water in these masses moves through the aquifer, it is heated or cooled by the exchange of heat between the water and the aquifer materials.

Changes in the pattern of temperatures in the vicinity of Lock 8, shown on the maps in figure 21, show the effect of operation of the dam at Lock 8 on the location of principal areas of infiltration, and the volume of infiltration. During the navigation season when the dam is in operation the contours arc around the end of the dam in response to underflow along these paths, except in late October and early May when river temperature is about

Well number USGS	Well field	Maximum temperature °F	Date	Minimum temperature °F	Date	Temperature range °F
249-359-75	S-1 1/	64.0	10/10/60	43.0	4/24/61	21.0
-77	S-3	64.0	10/10/60	43.0	4/24/61	21.0
-83	S-9	62.0	10/25/60	48.0	5/22/61	14.0
-84	S-10	58.0	10/24/60	49.0	7/ 3/61	9.0
-94	S-11	--	3/	51.5	5/ 1/61	--
-95	S-12	58.0	11/21/60	49.0	5/21/61	9.0
-91	R-1 2/	59.0	9/ 8/60	43.0	5/ 4/61	16.0
-92	R-2	59.0	9/ 8/60	45.5	4/20/61	13.5
-93	R-3	65.0	9/18/60 4/	43.5	4/20/61	21.5
Mohawk River		77.0	7/31/61	32.0	12/14/60 to 2/21/61	45.0

1/ Schenectady well field number.

2/ Rotterdam well field number.

3/ Well rarely pumped in fall of 1960.

4/ Highest temperature occurred 17 days after final seasonal peak temperature of Mohawk River water of 76°F on September 1, 1960.

the same as that of water in the aquifer. When the dam is removed in mid-December, underflow beneath and around the dam is essentially stopped and the temperature of the water previously infiltrated immediately above the dam declines very slowly, because of the reduction in hydraulic gradient, as heat is exchanged with the aquifer. At the same time, water level in the aquifer declines below river level in the area immediately below the dam and water colder than that already in the aquifer begins to infiltrate in that area. The "bunching" of the isotherms along the river just below the dam during January, February, and March, represents the steep temperature gradient between the water now moving very slowly through the aquifer (if at all) from above the dam and the cold water (32°F) newly infiltrated from the river just below the dam. On February 16, 1961, ground-water temperature at the west end of the dam (well 249-359-43) was about 53°F whereas the temperature in well 249-359-59, about 400 feet below the dam was between 32°F and 33°F.

The "bunched" isotherms extend slowly toward the well fields as cold water infiltrating below Lock 8 exchanges heat with the warmer aquifer materials, and progressively reduces water temperatures in the aquifer.

Only two floods of any significance (September 1960 and February 1961) occurred during the period of temperature measurements, and neither of these crested above the level of the river bank in the vicinity of the well

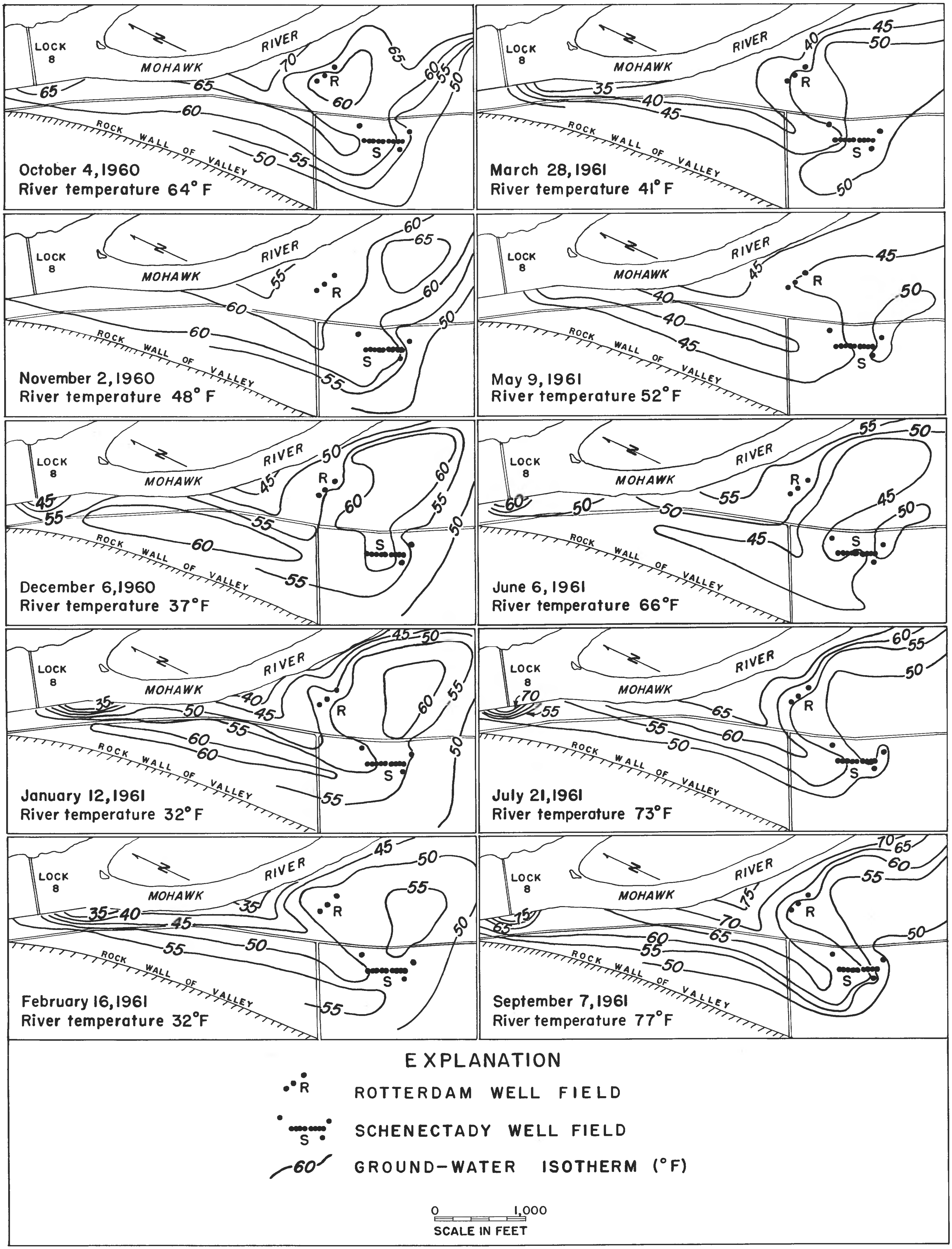


Figure 21.--Maps showing ground-water temperatures in the vicinity of the well fields at different times in 1960 and 1961.

fields. (See figure 12.) Water temperatures in some wells adjacent to the river declined as much as 3°F during the flood in February, but this change had a negligible areal effect on water temperatures in the aquifer. The increase in infiltration that occurs during the rising and peak river levels of a flood is followed by a period of less than normal infiltration or an actual return flow to the river during the recession of river level.

Figure 22 shows contour lines connecting points of equal annual range of water temperature in the well field area. The contours are based on the data shown in the table above and the maximum range of water temperature measured in the observation wells.

The temperature of the water changes as it travels through the aquifer toward the wells. These changes occur as a result of (1) mixing with other water that entered the aquifer at different places, times, and temperatures, and (2) heat transfer to or from the aquifer materials. According to Rorabaugh (1956, p. 162) the temperature range of water discharged from an infiltration supply and the time lag between peak water temperatures in the river and in the wells depends on a large number of variables. These are: temperature of river water, distance of wells from the river, spacing of pumping wells, pumping rate, volume of aquifer, porosity of aquifer, amount and temperature of ground-water flow from the land side, and the specific heat of the aquifer materials. The water being pumped at a given time moves from the river to the wells by various paths and at rates determined by the hydraulic gradient and the transmissibility of the aquifer.

The general pattern of the contours shown in figure 22 is very similar to the contours showing periodic temperatures in figure 21. The fact that the greatest deflection of the contours away from the river (path "A", fig. 22) does not shift significantly during the year is striking. The existence and stability of this deflection is evidence of high transmissibility. However, the location of the path does not coincide with the thickest part of the aquifer. (See plates 2 and 3.) Hence, it must reflect the zone of maximum permeability in the aquifer. The stability of the pattern of contours in figure 22 is believed to be partly due to localized infiltration area. Both figures 21 and 22 show that the range of fluctuation and rate of temperature change in a broad area of the aquifer, south from the town field and east of the city field, are very low as compared to that along path "A". This suggests that the rate and amount of water movement through that area of the aquifer are also very low as a result of almost negligible infiltration from the adjacent reach of the river. The fact that the Rotterdam well field lies outside of path "A" in both figures 21 and 22 further supports the suggestion of lower permeability of the aquifer in that well field area, which was made on earlier pages of this report.

Variation of temperature with depth in the aquifer

Figure 23 shows the variation of ground-water temperatures with depth in well 249-359-61 at various times between October 1960 and September 1961. The well is located on the east side of flow path "A" (fig. 22) about 300 feet from the river. It was drilled into the surface of the till underlying the aquifer, then the casing was pulled back so that the bottom of the

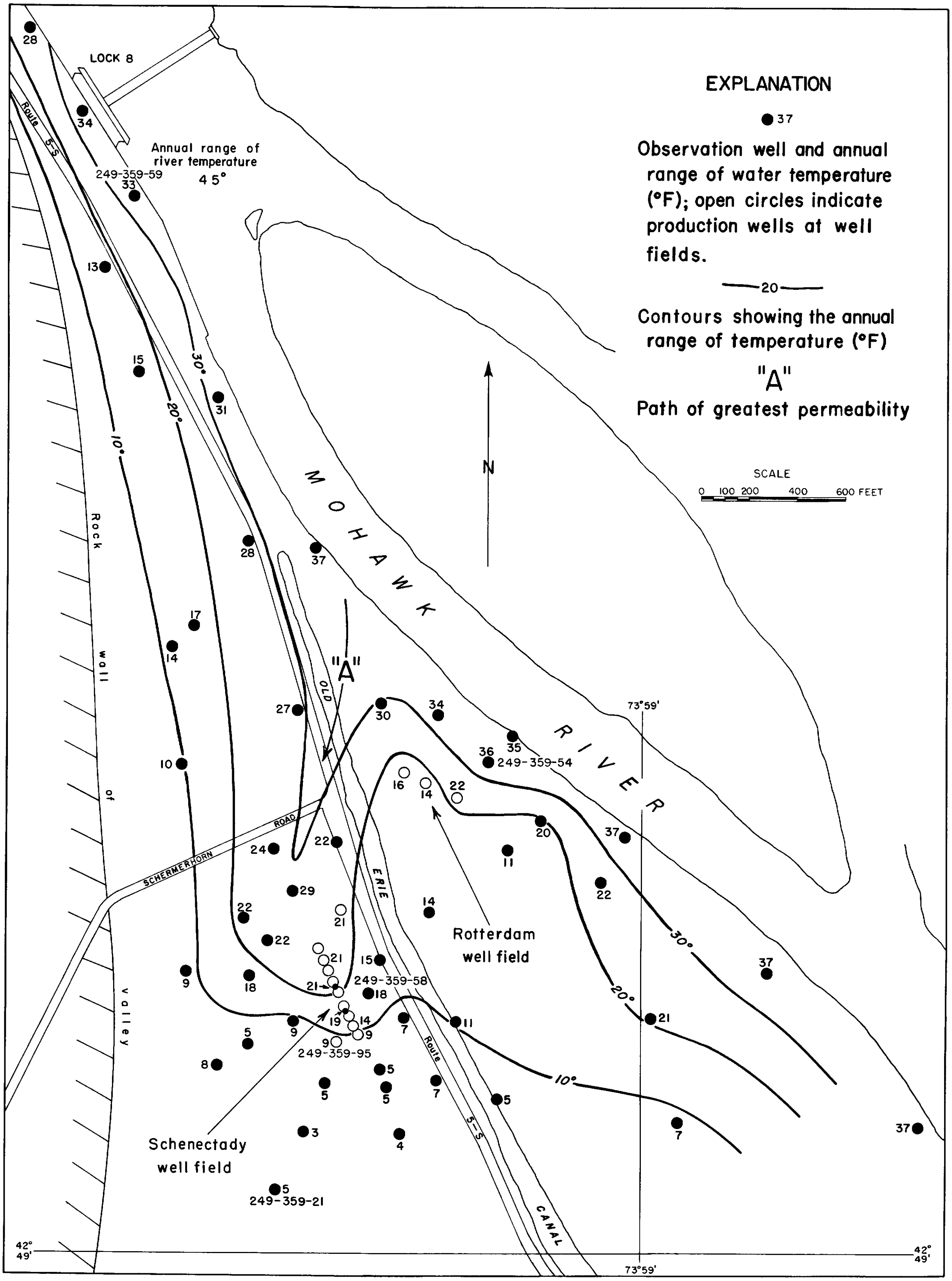


Figure 22.--Map showing the annual range of ground-water temperature in the vicinity of the well fields for the year ending September 7, 1961.

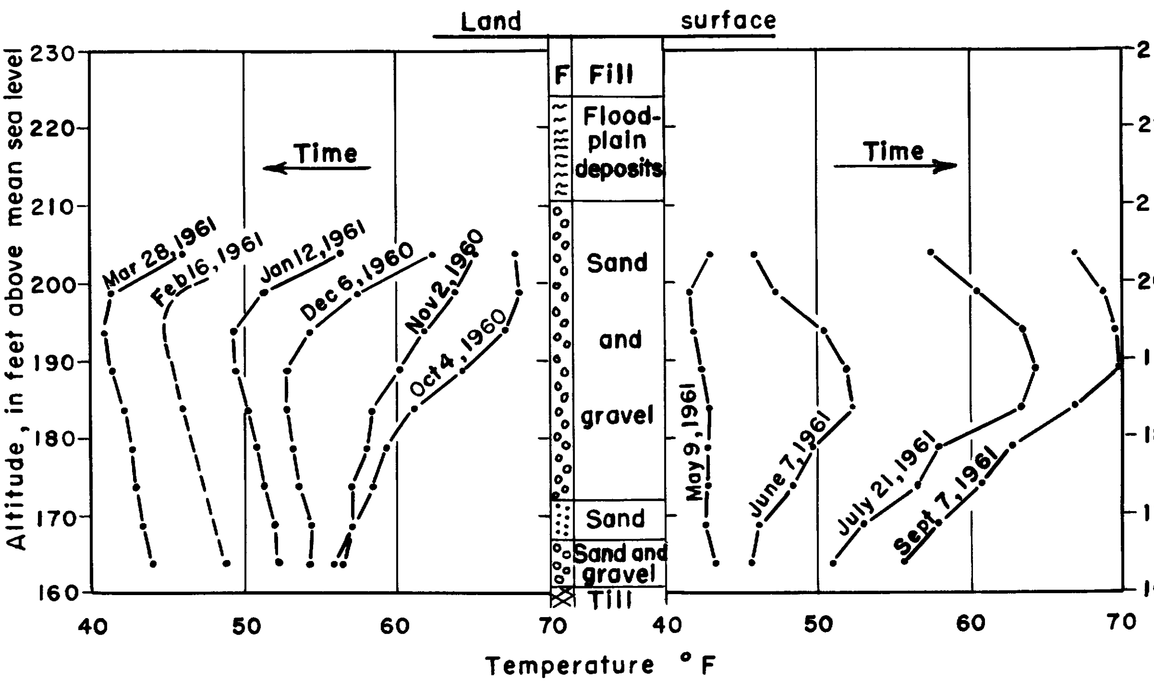


Figure 23.--Variation of ground-water temperature with depth in well 249-359-61 at different times in 1960 and 1961.

casing would be in sand and gravel a foot above the till surface. It was the only observation well drilled during the present investigation to fully penetrate the aquifer. In June, July, and September 1961, the deflection of the temperature lines to the right between altitudes of about 180 and 200 feet indicates that the warmest water was moving through this zone. During the period from October 1960 to March 1961, the greatest deflection of the temperature lines was between altitudes of about 190 and 200 feet, indicating that the coldest water was moving through this zone of the aquifer. Differences in the annual range of temperature between zones of the aquifer indicate relative differences in the permeability of the zones: the greater the range, the higher the permeability. On this basis the most permeable zone of the aquifer would appear to be between altitudes of about 180 and 200 feet. The fact that the coldest water moves past the well at a slightly higher altitude than the warmest water probably is due to the fact that areas of infiltration or paths of ground-water flow change in response to differences in the level of the river.

The smaller variation of temperature in the lower part of the well than in the upper part may indicate that the lower part of the aquifer is less permeable, and that the velocity of water in the lower part of the aquifer is lower than in the upper part. It also may indicate that the water in this zone entered the aquifer at more distant places than water in the upper part, and hence, the variation of the temperature of the water in the lower zone has been moderated by mixing of waters that have entered the aquifer at different times, temperatures, and places.

Relationship of river temperature to water temperature in the aquifer

Figure 24 shows the water temperature records of the Mohawk River and six wells in the well field area from August 1, 1960 through July 31, 1961. The well locations are shown in figure 22. It may be seen that, with the exception of well 249-359-21, the graphs are similarly shaped but differ substantially as to (1) maximum and minimum temperature, (2) the date each was recorded, and (3) in the rate of temperature change. The similarity of the records of wells 249-359-54 and -59, and that of the river is evident; the similarity of the records of wells 249-359-58, and -95 and the river is less obvious, but discernible, and there is no apparent relationship between the temperature of well 249-359-21 and the river. All of the wells are in the same aquifer as the well field, except well 249-359-21, which is in the low-permeability sand deposit south of the aquifer and which is not supplied by infiltration from the river.

The range of fluctuation and similarity of record in the other five wells and the river clearly shows that the water in the wells is infiltrated from the river. The differences of these five temperature records in range of fluctuation and in date of maximum and minimum temperature are functions of the hydraulic distance of the individual wells from the river, the velocity, temperature, amount of water in transit, and the temperature of the aquifer materials. For example, well 249-359-59 is physically closer to the river's edge than well 249-359-54 (fig. 22), but figures 19, 20, and 21 show that, during the navigation season, the water reaching the former well enters the aquifer above Lock 8 and that water reaching the latter well enters the aquifer from the river immediately adjacent to the well, a much shorter hydraulic distance away. Hence, river water reaches well 249-359-54 much sooner than it reaches -59, and the thermograph of -59 is more subdued during this period. However, during the non-navigation season, river water enters the aquifer immediately below Lock 8, much closer (hydraulically) to well -59, and water in that well reaches a much lower temperature than it does in well -54. In contrast to the complexities of temperature relating to 249-359-59, there is very little shifting of infiltration areas supplying the other four wells. There is an appreciable difference in lag time behind river peaks of summer high and winter low temperatures, and correlative peaks in these wells. Wells 249-359-58 and -95 are located at much greater physical and hydraulic distances from the river than 249-359-54 and -59, hence, their thermographs show a smaller annual range of temperature, lower rates of change, and greater time lag in reaching peak high and low temperatures. Figure 24 shows that the lag in starting an upward temperature trend is a few days longer than the lag in starting a downward trend in most of the wells. This is because the upward trend of river temperature usually begins suddenly with the spring thaw and spring flood, while the downward trend begins slowly after a prolonged period of high temperature.

The relationship of river temperature to water temperature at two points in the aquifer is illustrated in another manner in figure 25, which shows that temperature relationships are different during the upward and the downward phases of the annual temperature cycle. Short-term variations of climatic factors and substantial change in pumping rates of the well

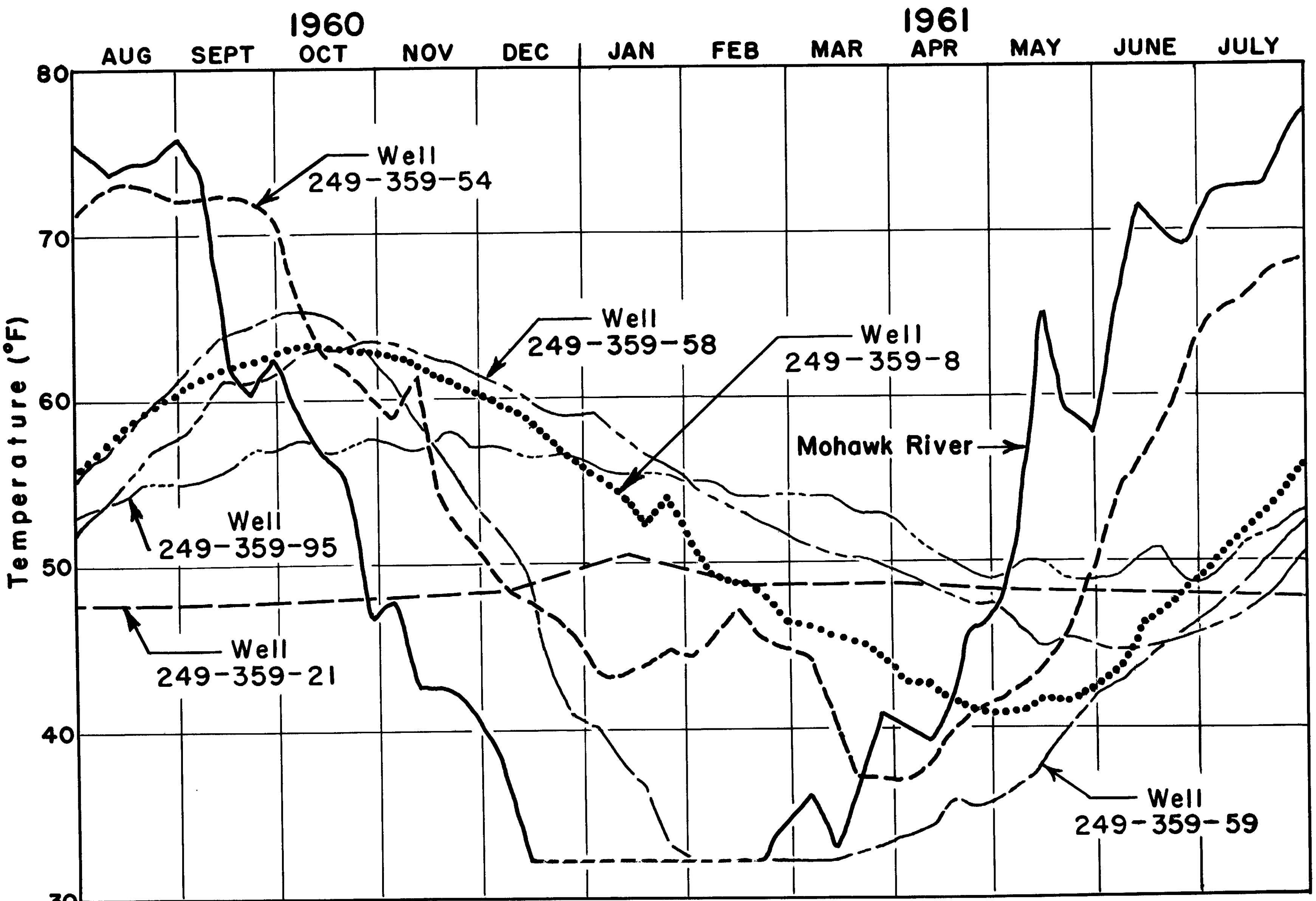


Figure 24.--Graph showing the temperature of river water and of water in several wells in the vicinity of the well fields during the year ending July 31, 1961.

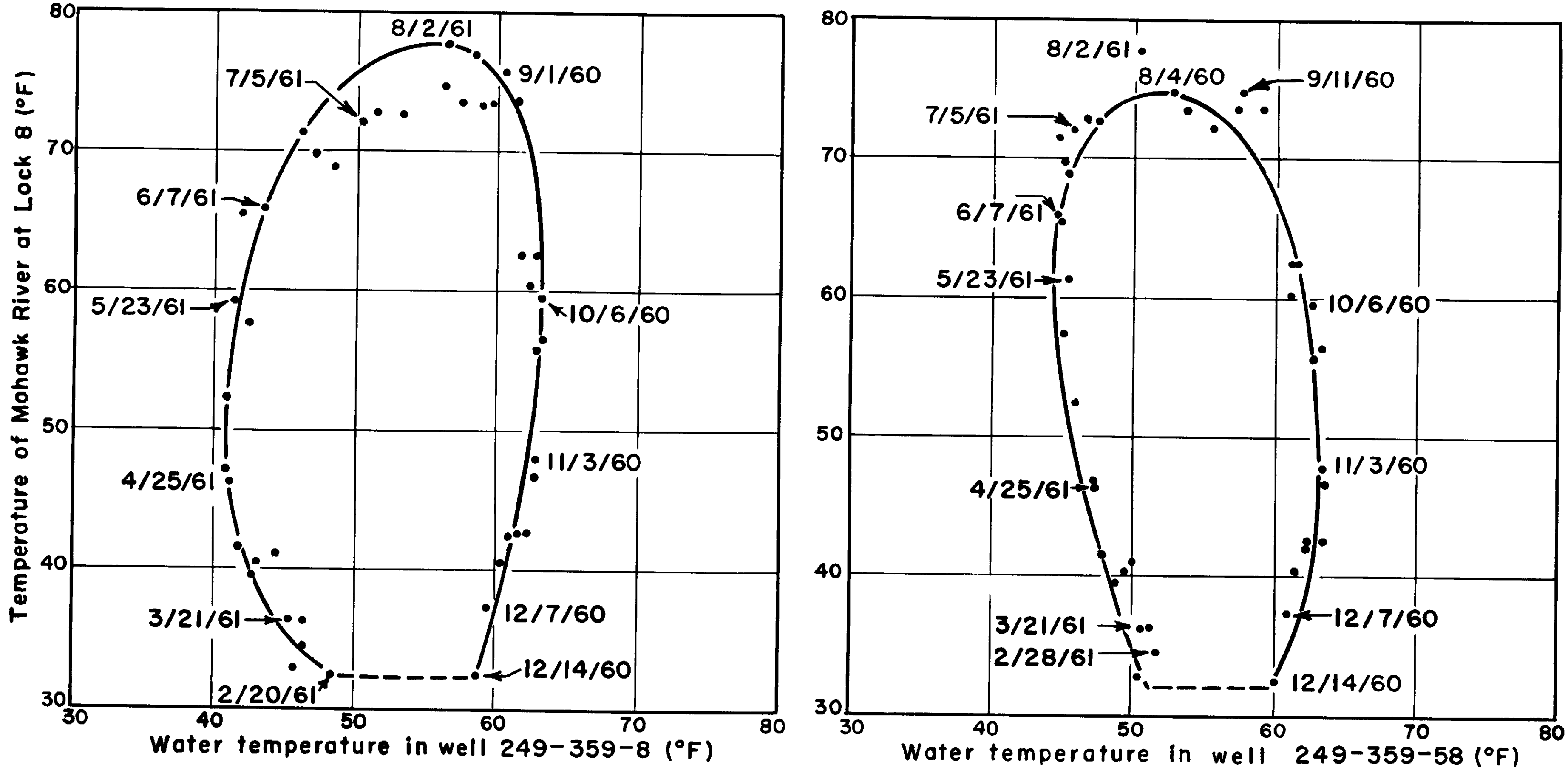


Figure 25.--Graphs showing the relationship of river temperature to water temperature in two wells in the vicinity of the well fields during the period from August 1960 to August 1961.

fields will change the detailed shape of these graphs from year to year. The period of temperature decline in the river is about 4 1/2 months, the period of rising temperature about 5 1/2 months, and the temperature is stable for about 2 months during the winter. In the wells, however, a different relationship exists - the converse is true and the ground-water temperature declines for about 7 months and rises for about 5 months. This is because ground-water temperature continues to decline during the winter period when river temperature is stabilized at about 32°F.

The temperature fluctuations in well 249-359-54 (fig. 24) during January and February 1961 indicate that some ground water reached this well from the Scotia area as underflow beneath the river during those months. The temperature of water in this well was nearly as high as that of the river during the summer months, indicating that most of the water reaching the well had traveled a relatively short distance in a relatively short time. In the fall of 1960, the temperature of water in the well declined with, but lagged about a month behind, the river temperature. However, early in January 1961, the temperature of water in the well began to increase and continued to do so until the flood in mid-February, after which it declined again. This anomalous change in temperature reflects the fact that when the dam at Lock 8 was removed in mid-December 1960, the boundary of the cone of depression around the well fields expanded across the river and began to divert ground water (at a temperature of about 50°F) from the north side of the river to the well field. (See figure 20.) When the diverted ground water began to arrive at well 249-359-54 early in January, the temperature of the water in the well began to rise and continued to do so until the flood in mid-February fully recharged the aquifer and caused a shrinkage of the cone of depression. After the flood only infiltrated river water reached the well and the temperature of water in the well resumed a downward trend similar to that of other wells in the aquifer. Diversion of ground water from the Scotia area did not occur again during the spring of 1961 (fig. 24) because of the seasonal change of climatic and hydraulic factors of the system in April (change of temperature, infiltration area, gradient, ground-water levels).

Velocity of ground-water flow through the aquifer

Ground-water temperatures in the vicinity of the well fields also provide a basis for evaluating the relative velocities of ground-water flow through various parts of the sand and gravel aquifer. Actual velocities in the aquifer, however, cannot be determined from the available data because (1) the water must exchange heat with the aquifer materials through which it moves, and the rate of exchange is affected by several hydraulic variables, (2) most of the infiltration occurs through the upper parts of the riverbanks in a moderately large area and not along the centerline as assumed in these estimates, (3) the distance from a well to the effective area of infiltration is undoubtedly different from that assumed, and (4) some mixing of waters infiltrated at different times, temperatures, and places occurs within the aquifer. It must also be noted (fig. 25) that there is some seasonal difference in the lag of ground-water temperature behind river temperature between rising and declining trends. In the

development of this index, it was assumed that the center of the river is the principal area of infiltration for each well and that the water follows a flow path to the well that is perpendicular to the water-table contour lines shown on the maps in figures 19 and 20. The velocity index was established by dividing this flow-path distance between the individual wells and the center of the river by the time between the date of peak temperature in the well and the date river temperature declined below the peak temperature of water in the well. The approximate temperature time lag, the velocity index, and the assumed direction of water movement through the aquifer are shown on the map in figure 26. The temperatures used in constructing figure 26 were measured during the navigation season in the fall of 1960.

As developed here, the velocity index indicates the relative velocity of water movement in various parts of the aquifer. Ground water appears to move about twice as fast along flow path "A" shown in figure 26 as it does in other parts of the area. This indicates that the most permeable part of the aquifer is along this flow path. It must be noted here that the data in the thickest part of the aquifer are from the coarse sand and gravel units. None of the wells is finished in the underlying sand unit, and because velocities are directly proportional to permeability, velocities in the sand are likely to be considerably lower than in the sand and gravel.

Contour lines in figure 26 show the thickness of the aquifer in the well field area below an altitude of 185 feet. The dashed pattern indicates the area in which the base of the aquifer is below an altitude of 165 feet and the aquifer is sufficiently thick for the construction of high-capacity wells. These altitudes are specified because they represent the approximate top and bottom altitudes of many of the well screens in the present Schenectady wells. If exploration of the sand unit in the lower part of the aquifer indicates a high permeability, future wells should be drilled into the deepest parts of the aquifer to take advantage of the greatest available drawdowns (dashed pattern area, fig. 26).

FACTORS AFFECTING THE YIELD OF THE AQUIFER

It is evident from the preceding discussions that the yield of the aquifer is influenced by a number of factors, both natural and manmade, some of which vary independently through the year. These are:

(1) The presence of silt and clay deposits of very low permeability on the riverbed which retards the movement of water from the river into the aquifer.

(2) The temperature of water in the river and the aquifer which causes seasonal changes in the permeability of the aquifer and riverbed materials.

(3) River level, in that:

a. the hydraulic gradient between the river and the aquifer is partly controlled by seasonal changes in river level for navigational purposes;

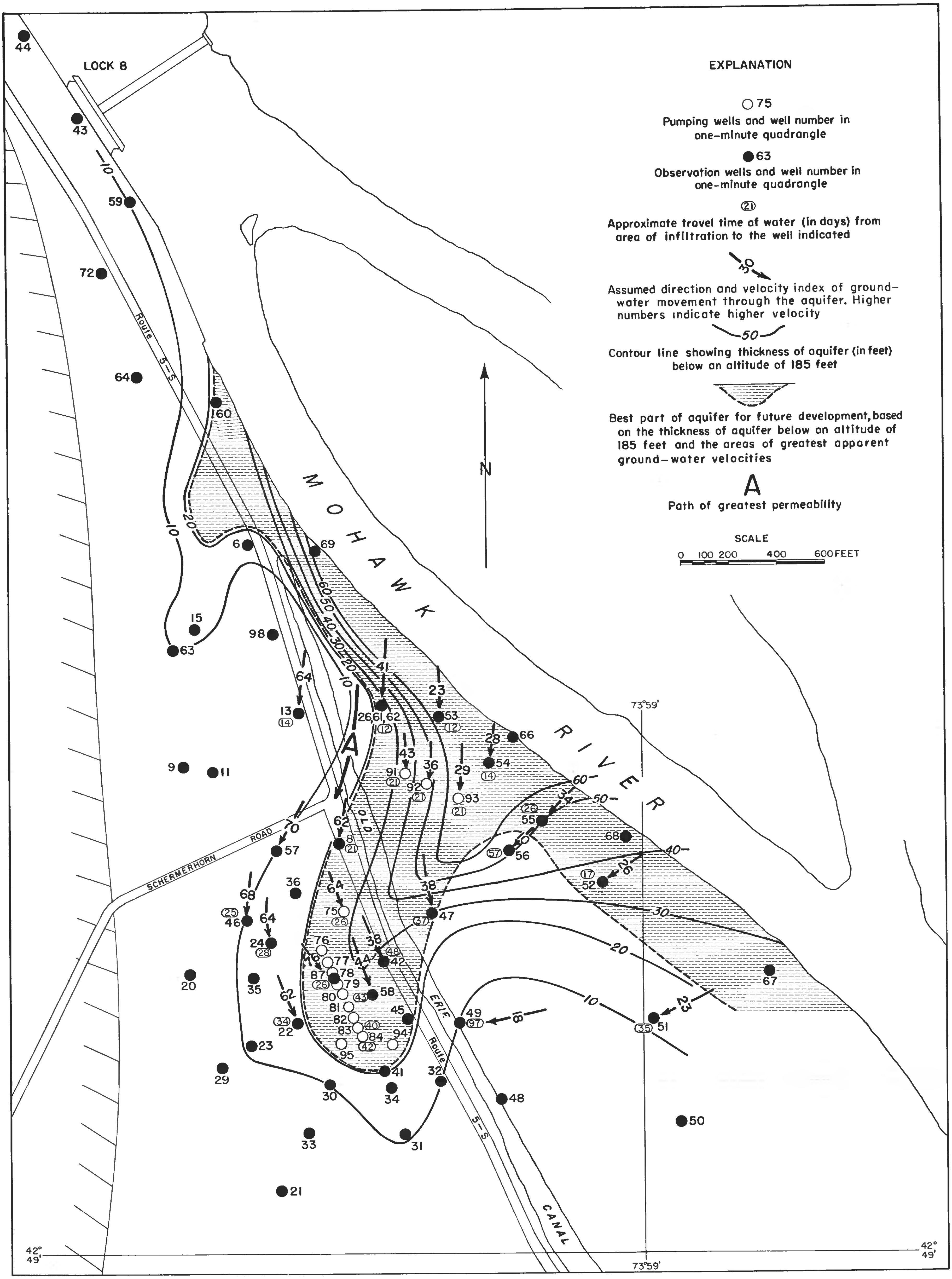


Figure 26.--Map of the vicinity of the Schenectady and Rotterdam well fields showing the assumed direction of ground-water movement, the velocity index, the approximate travel time between the infiltration of water from the river and its arrival at different wells, and the thickness of the aquifer below an altitude of 185 feet.

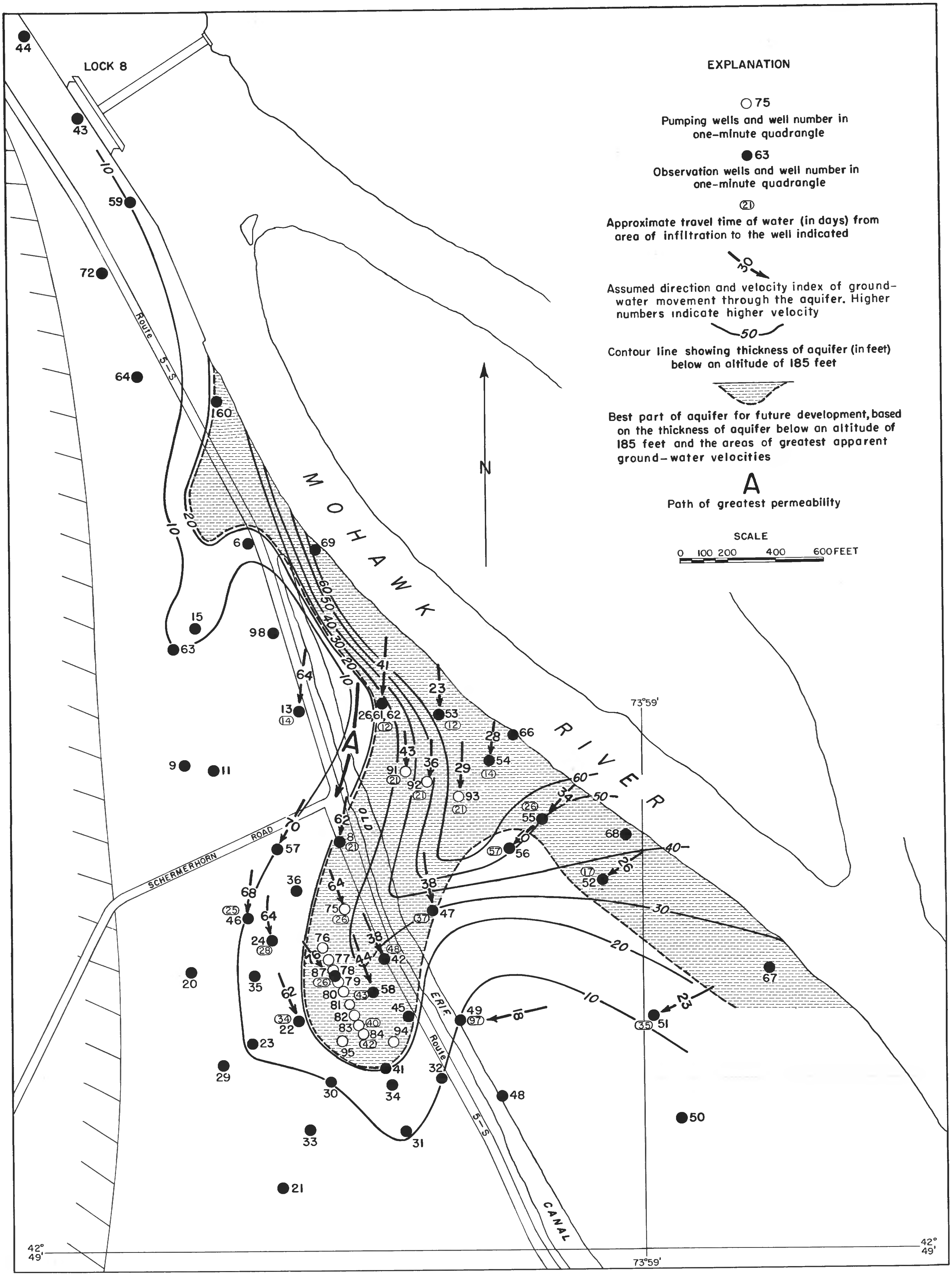


Figure 26.--Map of the vicinity of the Schenectady and Rotterdam well fields showing the assumed direction of ground-water movement, the velocity index, the approximate travel time between the infiltration of water from the river and its arrival at different wells, and the thickness of the aquifer below an altitude of 185 feet.

b. the location of the principal infiltration areas also changes significantly due to the seasonal changes in river level;

c. minor short-term fluctuations of river level above the controlled levels, caused by climatic factors and/or channel conditions, which replenish storage in the aquifer and cause the highest water levels possible in the aquifer at various pumping rates.

(4) The permeability of the aquifer including differences in permeability from zone to zone within the aquifer.

(5) The volume of storage available in the aquifer which supplies part of the yield when pumping exceeds infiltration.

(6) The saturated thickness of the aquifer which affects the transmissibility and limits the drawdown available in wells.

It is easily seen that these factors, operating simultaneously, will cause a continual variation of the yield of the aquifer from a maximum in the summer to a minimum in the winter. Within each year two widely different sets of conditions exist in the infiltration system as a result of controlled changes of river level for the operation of the Barge Canal - the navigation season, and the non-navigation season. For purposes of clarity, the yield of the aquifer under each set of conditions will be discussed separately.

The effect of the factors noted above on the yield of the aquifer may be evaluated by study of the specific capacity (yield per foot of drawdown) of the aquifer at the 1960-63 pumping rates. Figures 19 and 20 show that the adjacent well fields may be considered as a single center of pumping. The figures also show that the water levels in well 249-359-58, an unpumped observation well, are generally representative of the water level in the aquifer at the center of pumping. In the following discussions the specific capacity of the aquifer was obtained by dividing the combined pumping rates of the well fields by the difference in feet between river level below Lock 8 (assumed to represent static water level in the aquifer) and the water level in well 249-359-58.

These discussions <u>do not</u> include the water levels in the wells being pumped which are lower than those in well -58 as a result of clogged well screens or other sources of well loss.

<u>The specific capacity of the aquifer during the navigation season</u>

Figure 27 relates the specific capacity of the aquifer only to river temperature which is an important factor in the yield of the aquifer. However, it must be recognized that other factors also affect the yield and specific capacity, but cannot be evaluated quantitatively at this time. Thus, the specific capacity shown in figure 27 is the integrated result of all the factors involved, during the period of time indicated, and it is

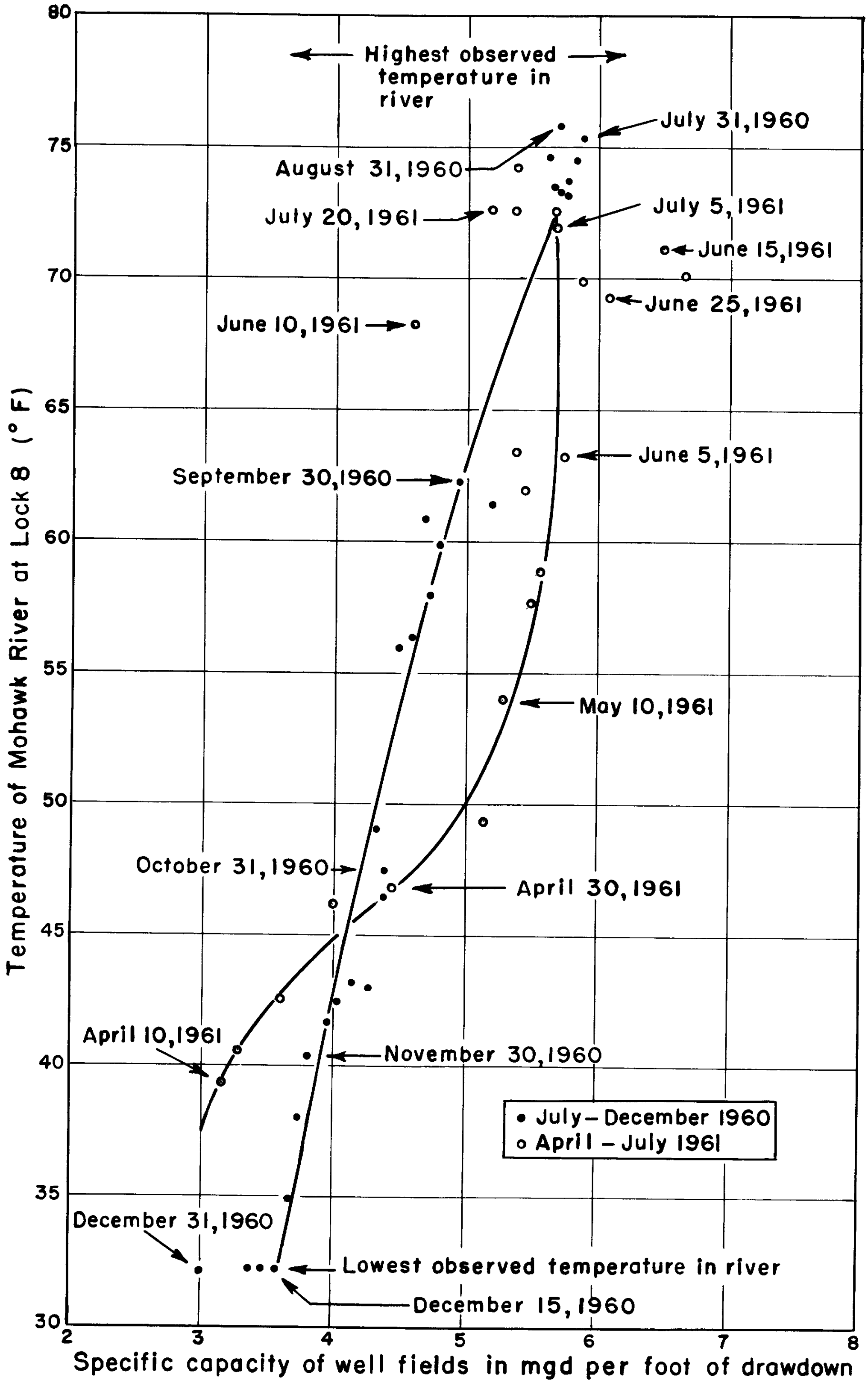


Figure 27.--Graph showing the relationship between river temperature and the specific capacity of the aquifer in non-flood periods during the navigation seasons in 1960 and in 1961.

intended only to illustrate that result. The general effect of seasonal differences in the relationship of the temperature of river water to the yield of the aquifer is immediately apparent. The figure shows that the specific capacity of the aquifer ranged from a high of about 6 mgd in August when river temperature was highest, to a low of about 3.5 mgd per foot of drawdown in December when the river temperature reached 32°F. The complex curve shown in figure 27 indicates that at any given river temperature, with the exception of two points, there are two values for the specific capacity of the aquifer. The curve takes a looped shape principally because the annual cyclic changes of temperature in the river and aquifer are out of phase with one another, as shown in figures 24 and 25.

If water temperatures were the only factors which changed, then the relationship of specific capacity and river temperature would be a more rounded loop, similar to that shown in figure 25 for well 249-359-58. Under such conditions the highest specific capacity would be in September rather than June as shown in figure 27. However, because of changes in pumping rates, infiltration rates, hydraulic gradient, saturated thickness of the aquifer, and possibly other factors, the relationship during 1960-61 was as shown in figure 27. It is evident from inspection of figure 14 that one or more factors involved have changed substantially during the period of April through July 1961, and the same period in 1963, and that specific capacity-river temperature relationships during 1963 would not plot on the 1961 data curve in figure 27. A brief analysis of the specific capacity data, similar to that mentioned by Rorabaugh (1963, p. 58), suggests that one important reason for the difference in specific capacity is a reduction in transmissibility of the aquifer due to increased pumping rates and drawdown in the 1963 period.

In August the temperature of river water was at its highest point, and water in the aquifer was approaching its highest point (fig. 24), hence, the coefficients of permeability of the riverbed and the aquifer were also at or near their highest values. At this same time the river level was at its highest controlled level on either side of the dam at Lock 8. Thus, under the influences of the high gradient between river and aquifer, high river level above Lock 8, and high permeabilities, river water was freely infiltrating the upper parts of the riverbank above Lock 8. The quantity of infiltration is equal to that part of the pumping rate supplied by infiltration plus the natural discharge from the aquifer through the riverbed below Lock 8.

At the end of August the river temperature began to decline and caused a concurrent decrease of the coefficient of permeability of the riverbed materials. Ground-water temperatures reach their peak and begin declining in October but remain higher than river temperature through the winter (fig. 24). Thus, from October until the river reaches 32°F the permeability of both the riverbed and the aquifer are declining due to temperature change. As a result the trend of water level in the aquifer diverges from the trend of river level (fig. 12) to increase the hydraulic gradient necessary to maintain the required amount of infiltration, and the specific capacity decreases. When the river reaches 32°F, the coefficient of permeability of the riverbed materials reaches its lowest value of the year resulting in the smallest amount of infiltration to the aquifer.

With the beginning of the navigation season in the spring, river levels are again at the highest controlled levels, and river temperature is initially lower than that of water in the aquifer. The specific capacity of the aquifer increases slowly with rising river temperature and replacement of storage in the aquifer until the temperature trend in the aquifer is reversed. The specific capacity thereafter increases more rapidly in the early summer but as water temperatures in both river and aquifer approach seasonal peaks, the rate of increase is reduced.

The amount of infiltration occurring below Lock 8 during the navigation season is unknown. Earlier discussions of water-level relationships, the character of the materials on the riverbank and overlying the aquifer, and water temperature in the aquifer, strongly suggest that a relatively small amount of water is infiltrated in the vicinity of the well field. This probably occurs during the brief periods when the river level exceeds an altitude of 213 feet (fig. 12). During periods of low stable water levels, as in June-July 1963, it is believed that infiltration below Lock 8 is negligible. Unpublished data from the files of the Chief Operator at Lock 8 show that the river level above Lock 8 was also very stable at altitudes slightly above and below 226 feet during this same period. Thus, during June-July 1963, water could not enter the aquifer as freely as it does during periods of normal summer fluctuation, and it was forced to enter the aquifer through a lower and less permeable zone of the riverbed. As a result of this, and substantially increased pumping rates, the water level in the aquifer declined to provide the steeper hydraulic gradient needed to infiltrate the amount of water required.

The specific capacity of the aquifer during the non-navigation season

When river temperature reaches 32°F, near the end of the navigation season, the permeability of the riverbed reaches its lowest value and cannot in itself further reduce the amount of infiltration to the aquifer. However, figure 24 shows that the water temperature in the aquifer is still declining and, therefore, the reduction of the coefficient of permeability of the aquifer is continuing. Within a few days after the river reaches 32°F, the dam at Lock 8 is removed. This greatly reduces the hydraulic gradient between the river and the aquifer above Lock 8, and lowers river level into the zone of thickest riverbed deposits. Below Lock 8 the removal of the dam halts discharge from the aquifer to the river, through the riverbed, and establishes recharge to the aquifer in that same area. For a few days, depending on the river stage when the dam is removed, the water level in the aquifer declines at a rate of about 0.25 foot per day until new flow paths through the aquifer in the vicinity of Lock 8 are established. When this occurs the decline of water levels is reduced to about 0.06 foot per day at pumping rates of 16-18 mgd.

As a result of these changes in the system, the amount of infiltration is substantially reduced and it becomes less than the pumping rate, as shown by the continuous decline of water level in the aquifer (figs. 12 and 14). In order to maintain the pumping rate, water is taken from storage in the aquifer and water level in the aquifer declines (figs. 14 and 15). This causes a continuous reduction of the specific capacity of the aquifer below that shown in figure 27.

The fact that water level declines along a straight line indicates that (1) the increase in infiltration demanded by the increasing hydraulic gradient is negligible and ineffective in changing the rate of decline, and (2) the cross-sectional area of the aquifer decreases (the aquifer is "V"-shaped). If these two statements were not true, the decline of water level in the aquifer would not be a straight line but would tend to slowly level off. It is to be noted that water temperature in the aquifer becomes much lower in the winter time just below Lock 8 than in the vicinity of the well fields (fig. 21), hence, the permeability of the aquifer is relatively lower in the winter area of infiltration than in the vicinity of the well fields. It may also be noted that water moving into the well field area from the Scotia side of the river is much warmer than water reaching the well field from the river. These opposing temperature effects may cancel each other in the interior areas of the aquifer and do not appear adequate to change the rate of water-level decline. Both the water level and the specific capacity will continue to decline through the non-navigation season until storage in the aquifer is replaced, either by winter floods in the river, or by reinstallation of the dam at Lock 8.

At some point in time after the removal of Lock 8, the flashboards are removed from the Vischer Ferry dam and the river level below Lock 8 is lowered about 2 feet. This change in the river is reflected by a like decline in water level in the aquifer (figs. 12 and 14) over a period of 12 to 13 days. It is apparent that this reduction of river level causes a change in storage in the aquifer but does not change the infiltration rate or the specific capacity of the aquifer.

During those non-navigation seasons in which storage in the aquifer is replaced by floods, water levels in the aquifer rise to peak levels and then resume a downward trend again, but at a higher level. As a result of multiple floods, water levels in the aquifer remain relatively high throughout some seasons and, therefore, the specific capacity of the aquifer also remains relatively high. However, during those non-navigation seasons in which flooding does not occur, as in 1960-61 and 1962-63 (figs. 12 and 14), water levels in the aquifer and, hence, specific capacity are continually lowered throughout the season.

Thus, the specific capacity of the aquifer declines during the non-navigation season because of substantially reduced infiltration and removal of water from storage in the aquifer and because of declining ground-water temperature.

The reduction in infiltration cannot be measured directly, and the amount of water removed from storage cannot be computed because the available data do not adequately define the volume of the aquifer or the extent of the dewatering (cone of depression) of the aquifer. It is certain, however, that the infiltration was substantially less than the average pumping rate of 16 mgd during the non-navigation season of 1962-63.

Because the change in specific capacity of the aquifer during the non-navigation season is in part due to the change in water temperature in the aquifer, it may be correlated with the temperature in a given well. However,

such a correlation will also contain the effect on specific capacity of withdrawal of water from storage. Such a correlation would be very limited in application and would be further limited because water temperature in the aquifer varies both vertically and areally, and no single well will provide temperature data that is representative of the entire aquifer. To the extent that it shows the change in specific capacity of the aquifer related to the water temperature in a single well during a period of withdrawal of water from storage, figure 28 is presented on the following page.

In figure 28, if the reduction of specific capacity in the non-navigation season was due entirely to temperature effect on permeability, it would have been reduced only from about 3.5 mgd per foot of drawdown to about 3.1 mgd per foot at the end of the non-navigation season in 1960-61. The actual reduction to 1.9 mgd per foot was due to the temperature effect plus the withdrawal of water from storage. It is evident that the effect of water temperature in the aquifer, though perceptible, is less significant than the change in storage caused by reduced infiltration.

In 1962-63 the minimum specific capacity reached was 1.33 mgd per foot of drawdown at a pumping rate of 16.3 mgd on March 17, just before the spring flood. The available data show that water temperature in well 249-359-8 at this time is about 44°F, and it may be noted that this plots directly on the extended curve in figure 28. In those seasons in which flooding occurs, the specific capacity probably ranges from 2.5 to 3.5 mgd per foot of drawdown or more, depending on the frequency of floods. Figure 28, like figure 27, is based on trend lines drawn through water-level and pumping data (fig. 12) and observed water temperatures (fig. 24).

ESTIMATE OF THE MAXIMUM YIELD OF THE AQUIFER

The maximum yield of the aquifer is the maximum rate at which water can be withdrawn from the aquifer without drawing the water levels below the top of the well screens in wells which are drilled to the bottom of the sandy gravel unit of the aquifer, and which are equipped with 20-foot screens, as at present. Because of seasonal changes in navigational controls on the river and seasonal changes in river temperature, the maximum yield of the aquifer fluctuates annually through a large range of values. The lowest maximum yield of the aquifer is in winter during the non-navigation season when river temperature is at 32°F, the dam at Lock 8 and flash-boards at Vischer Ferry dam have been removed early in the season, and there is no winter flood to replace storage in the aquifer. The highest maximum yield of the aquifer is in summer during the navigation season when river temperature is above 70°F, and the level of the river above Lock 8 is at or above its normal controlled level. The yield during the spring and fall months of the navigation season is intermediate between the summer and winter values.

Maximum yield during the navigation season

The estimation of maximum yield of the aquifer in the navigation season is based on the observed relation of yield (in mgd), ground-water levels,

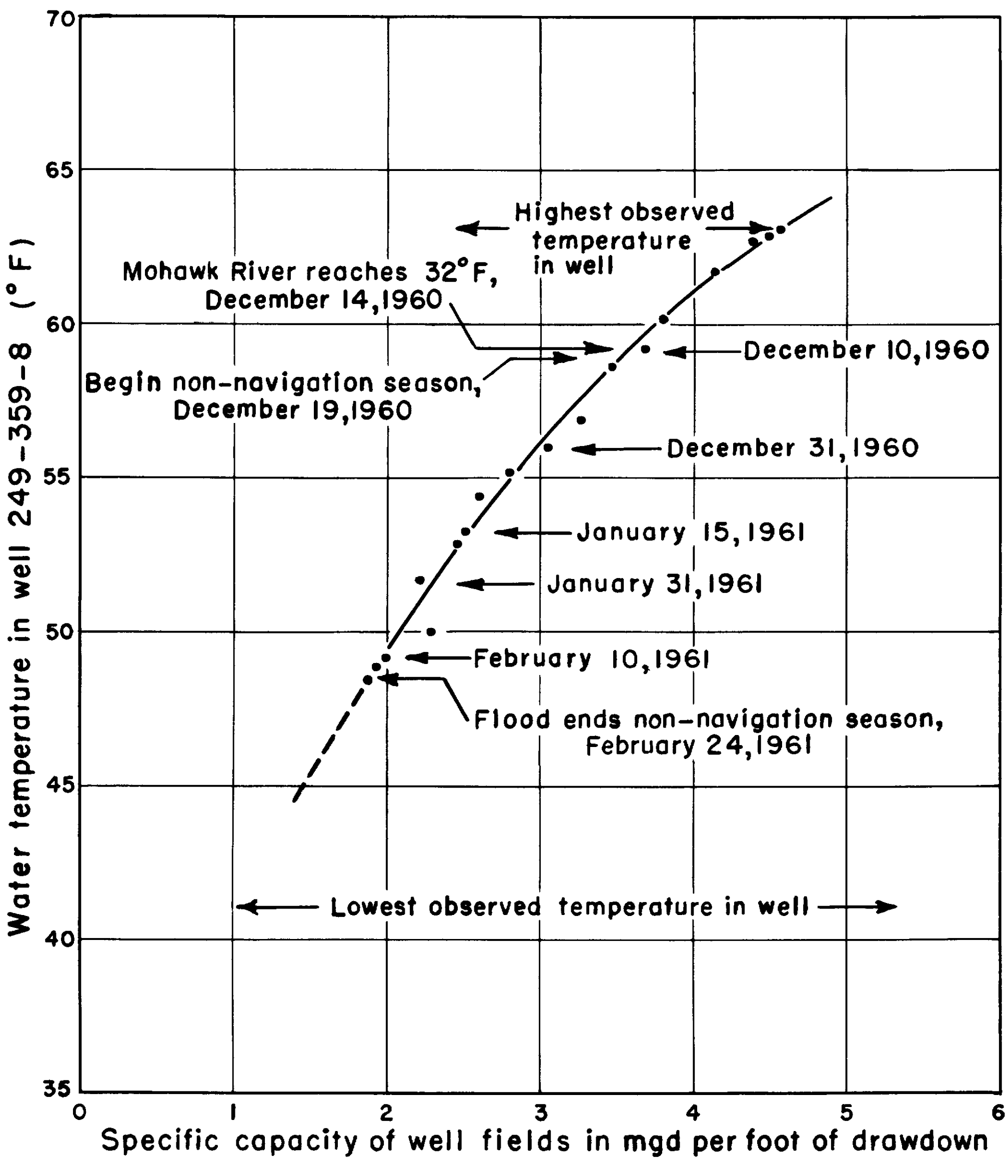


Figure 28.--Graph showing the relationship of specific capacity of the aquifer to the temperature of water in well 249-359-8 when temperature of the Mohawk River is 32°F. These relationships are not representative of the entire aquifer.

and river-water temperature, at a pumping rate of 18 mgd which are then projected for pumping rates that are 2 and 3 times that rate. The relationship of these three factors at the three different pumping rates is then projected over the full range of river temperature so as to provide a graph from which any one of the three factors may be estimated when the other two are given. The water levels in well 249-359-58 are assumed to be representative of water levels in the aquifer at the center of pumping.

The accuracy of the estimates depends upon the correctness of assumptions made in extending the data. These are as follows:

(1) The permeability of the aquifer is the same at all depths in the well field area.

(2) The permeability, thickness, and distribution of the riverbed materials will remain constant.

(3) The change of the coefficient of permeability of the riverbed materials with river temperature is one of the major factors which control the variation in yield of the aquifer in the navigation season.

(4) River levels, both above and below Lock 8, in the future will be at or above the normal pool levels maintained in 1960-61.

(5) Both well fields penetrate the same aquifer, and the combined pumping rate at the two well fields is the total pumping rate from the aquifer.

(6) The base of the sandy gravel unit of the aquifer is at an average altitude of 160 feet, and it is assumed that future wells will have not more than 20 feet of screen, as at present. It is undesirable to lower water levels into the screens of production wells, hence, it is also assumed that the minimum permissible altitude of water level in the aquifer is 180 feet.

If the riverbed material becomes thicker, or if the water level of the river declines below normal pool levels, the estimates of the yield of the aquifer will be too high.

The water levels in the well field area at the higher pumping rates may be interpolated from the relationships which existed during the period of this investigation. The conditions existing on September 2, 1960, during the navigation season, were selected for use. On that date river temperature was 75°F, and river level was at an altitude of 211 feet.

According to Theis (1940, p. 279) the depth of the cone of depression (drawdown) is related to transmissibility of the aquifer and to the pumping rate. At a given transmissibility the depth of the cone is directly proportional to the pumping rate when the saturated thickness of the aquifer is very great as compared to the drawdown. For a given pumping rate the drawdown is inversely proportional to the transmissibility. In addition to changing with variation in water temperature, the transmissibility is also directly related to the saturated thickness of the aquifer. In a thin aquifer such as that presently under discussion, when pumping rates are increased greatly and the drawdown constitutes a large part of the saturated thickness, the drawdown will exceed the direct-proportion relationship with the pumping rate.

On September 2, 1960, at a pumping rate of 21 mgd, the altitude of water levels in the aquifer were as follows:

well 249-359-59	211.14 feet
-60	210.23 feet
-6	209.19 feet
-98	208.26 feet
-8	207.43 feet
-58	207.15 feet

This line of wells (pl. 2) lies essentially along a flow line of ground water moving from the river to the well fields - a line essentially perpendicular to the water-level contour lines shown in figures 19 and 20. Some of the wells north of well -8, notably well -98, are near the western edge of the aquifer where the saturated thickness is much less than it is in the area underlying the river. (See plate 2.) At a pumping rate of 21 mgd at the well fields, the water levels in these wells are essentially the same as the water levels in wells drilled in the thicker parts of the aquifer, and would be representative of those in any line of wells drilled into the thicker parts of the aquifer at equivalent distances from well -58. However, at the higher pumping rates the aquifer in the vicinity of well -98 would actually be dewatered.

The projected water levels in well 249-359-98, and those more distant from the center of pumping, are assumed to be proportional to the increased pumping rates because the increased drawdown represents a relatively small part of the saturated thickness of the aquifer.

The predicted water levels in wells 249-359-8 and -58, near the center of pumping, will not be directly proportional to the higher pumping rates because the increased drawdown there materially reduces the saturated thickness of the aquifer. In order to predict the water levels in wells -8 and -58 at higher pumping rates, it is first necessary to determine the coefficient of permeability of the aquifer in the vicinity of the wells. The saturated cross-sectional area of the aquifer through which water must move to the center of pumping was determined along two lines of section (A-B and C-D, pl. 2) parallel to the water-table contours shown in figures 19 and 20. Section A-B passes between wells -98 and -8, and section C-D passes between wells -8 and -58. The saturated cross-sectional area of the aquifer along these two lines of section is shown below:

Altitude of water level in aquifer (feet)	Average saturated cross-sectional area above the altitude of 160 feet (square feet)	
	Section A-B	Section C-D
210	153,000	88,500
200	103,000	63,500
190	68,000	35,000
180	35,000	17,500
170	16,000	6,000

The average permeability of the aquifer materials across these lines of section was determined by solving the Darcy equation (Wenzel, 1942, p. 4) using these cross-sectional areas and the hydraulic gradients, and water levels prevailing at a pumping rate of 18 mgd. The average permeability of the aquifer across section A-B was determined to be about 140,000 gpd per square foot, and across section C-D about 500,000 gpd per square foot. The latter value is exceptionally high but is based on permeability values determined from pumping tests at the Schenectady well field. It is generally supported by the fact that the hydraulic gradient of the water table between wells 249-359-8 and -58 (figs. 19 and 20) is less than it is between wells -98 and -8, although the saturated cross-sectional area along section C-D is much smaller than along section A-B.

Using the average permeabilities of the aquifer across the two lines of section, the projected water levels in well 249-359-98 at the higher rates of pumping were used to determine the water levels in well -8 by a second expression of Darcy's equation. The water levels in well -58 at each of the higher rates of pumping were determined in a similar manner from the predicted water levels in well -8 at each of the higher rates of pumping. The saturated cross-sectional area was that along section C-D (pl. 2).

Figure 29 was then constructed by plotting the projected water levels in these two wells for the different rates of pumping during the navigation

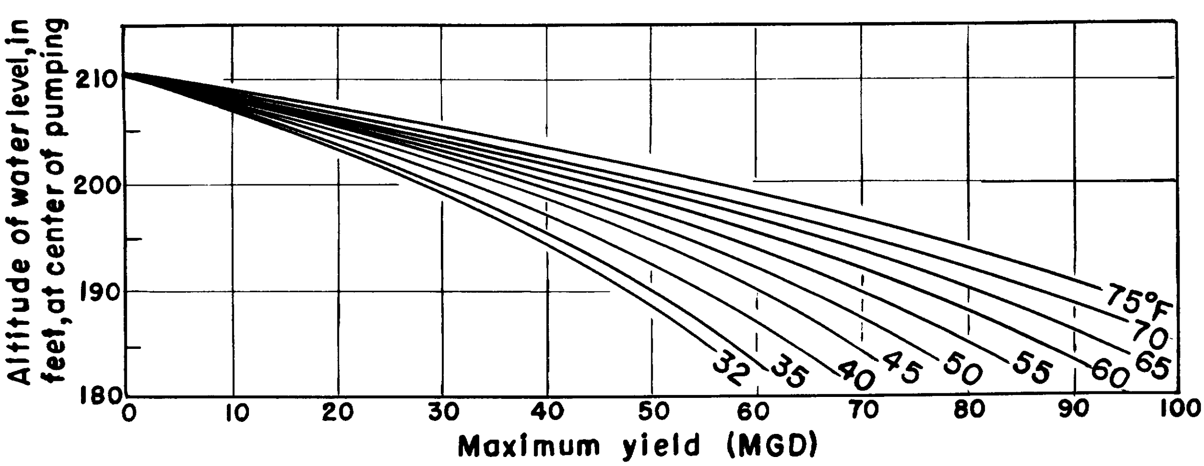


Figure 29.--Estimated maximum yield of the aquifer during the navigation season at various temperatures of river water, and the resultant water levels in the aquifer at the center of pumping.

season on the 75°F lines. The other temperature lines were then plotted by applying temperature-conversion factors for differences in viscosity of river water at different river temperatures. Figure 29 shows that the estimated maximum yield of the aquifer during the navigation season ranges from 60 to 100 mgd or more, depending upon water temperature in the river.

It is possible that some of the assumptions made in developing these estimates are not completely valid, and as a result the estimates may be inaccurate at very high pumping rates. It will be necessary to re-evaluate these estimates on the basis of observed relationships in the future when pumping rates are substantially higher than those of 1960-63.

Maximum yield during the non-navigation season--with recharge

The technique used in estimating maximum yield of the aquifer in the navigation season cannot be used in estimating the maximum yield in non-navigation seasons because a large part of the yield is derived from storage during the latter season. Ultimately, the maximum yield of the aquifer in the non-navigation season will depend upon the volume of the aquifer, the pumping rate, the frequency of replacement of storage in the aquifer during periods of high stage of the river, and the length of time that the river is at a temperature of 32°F.

The specific capacity of the aquifer at the end of the navigation season is about 3.5 mgd per foot of drawdown (fig. 27). During a very mild winter, with repeated periods of high water in the river, it is likely that the lowest specific capacity might easily approach or exceed 3.5 mgd per foot. Under more rigorous winter conditions, and fewer periods of high water in the river, the available data suggest that the specific capacity of the aquifer may drop to about 2.5 mgd per foot of drawdown. In the non-navigation season of 1961-62 storage in the aquifer was replaced by a single event in January, and the seasonal low water level reached an altitude of 203.5 feet at an average pumping rate of 16 mgd. These relationships approximate the poorest water level yield relationship in a non-navigation season under conditions of limited recharge and may be used to estimate the maximum yield of the aquifer.

Figure 30 shows, by solid lines, the estimated altitudes of water levels and the time, in days, required to reach the minimum permissible water level, at the center of pumping, at pumping rates equal to and substantially higher than those of 1960-63. The figure shows the extension of the observed rate of decline at a constant pumping rate, in the 1961-62 non-navigation season, to the altitude of 196 feet. At this altitude the transmissibility of the aquifer is only 50 percent of its original value, and the rate of water-level decline is doubled and projected to an altitude of 184 feet. At this altitude the transmissibility is only 50 percent of what it was at 196 feet, and the projected rate of water-level decline is again doubled and projected to an altitude of 180 feet. If the pumping rate is doubled the drawdown and rate of decline will also double. On these bases the water levels at pumping rates 2, 3, and 4 times the observed rate of 16 mgd in 1961-62 are estimated and shown in figure 30.

The non-navigation seasons in 1961-62 and 1962-63 were very long (93 and 98 days, respectively) from the start of water-level decline in those seasons to the beginning of the rising trend at the end of the season. If a 100-day non-navigation season be assumed, it may be seen in figure 30 that the estimated maximum yield of the aquifer, under conditions of some (but

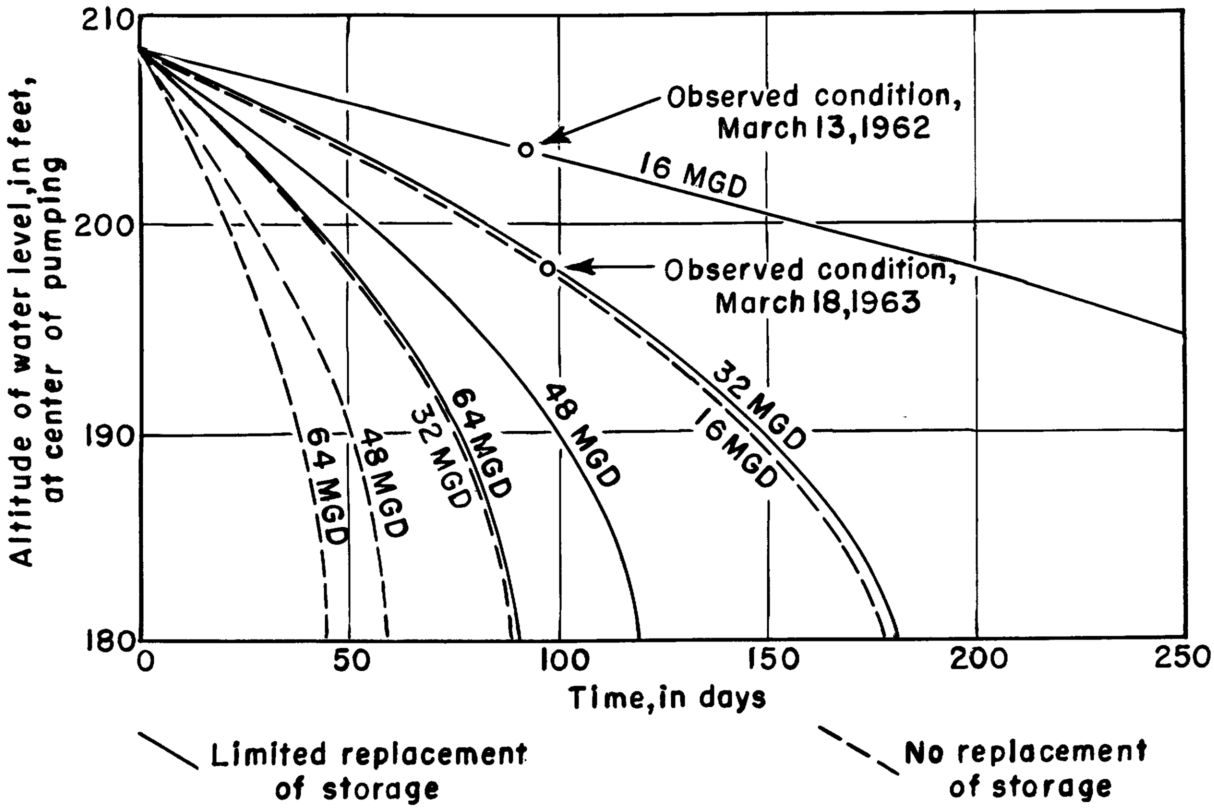


Figure 30.--Estimated yield of the aquifer in the non-navigation season, based on the extension of observed conditions and relationships.

limited) replacement of storage in the non-navigation season, would be about 60 mgd. It follows that under more mild winter conditions (more frequent replacement of storage) the maximum yield would be substantially more than 60 mgd. If the center of pumping were located closer to the river, it is possible that the maximum yield might be increased slightly to the extent that the hydraulic gradient between the aquifer and the river is increased. However, the available data are inadequate to predict what the yield and relationships might be in that area.

Maximum yield during the non-navigation season--without recharge

It has been previously noted that in some years there is no replacement of storage in the aquifer during the non-navigation season prior to the major spring thaw, and that the seasons of 1960-61 and 1962-63 are two recent examples. The maximum yield of the aquifer under such conditions is greatly reduced, and it may also be estimated by the techniques employed in the preceding section. The observed conditions and relationships of the non-navigation season 1962-63 are used as the basis for such estimates.

Just prior to the flood which ended the non-navigation season in 1962-63, the water level in well 249-359-58 was at an altitude of 197.8 feet

after pumping at a nearly constant rate of 16 mgd for 98 days (fig. 14). The dashed lines in figure 30 show the extension of these data, and its projection to pumping rates of 32, 48, and 64 mgd, with the center of pumping located in the area of the present Schenectady well field. It may be seen that the estimated maximum yield in this part of the aquifer, in a 100-day non-navigation season, without replacement of storage is about 30 mgd.

To summarize, it is estimated that the maximum yield of the sandy gravel unit of the aquifer in the area of the present city well field may be as low as 30 mgd in non-navigation seasons when storage in the aquifer is not replaced. The data in table 4 show that such conditions have occurred on an average of once every 6 years from 1917 through 1963. In non-navigation seasons during which there is limited replacement of storage, the maximum yield of the sandy gravel unit of the aquifer may be as low as 60 mgd in the area of the city well field. Obviously, the maximum yield under the latter conditions will be much higher if replacement of storage is more frequent during the season.

Use of the aquifer at other locations in the vicinity of the present well fields

Previous discussions have shown that there appears to be little infiltration from the river in the reach adjacent to the well fields, and that as a result there may be little circulation of water through that part of the aquifer south of path "A" figure 22, and east of the Schenectady well field. It also appears possible that the permeability of the sandy gravel unit of the aquifer is less in the area of the Rotterdam well field than it is near the present Schenectady well field. The sand unit which underlies the sandy gravel unit in the thicker parts of the aquifer has not been explored and cannot now be evaluated, but it is certainly of much lower permeability than the sandy gravel. Thus, although the total thickness of the aquifer is greatest near the river, the yield and specific capacity of the aquifer in that area may not substantially exceed that in the area of the Schenectady well field.

Dredging the riverbed downstream from Lock 8, so as to enlarge the present winter area of infiltration, may materially increase the yield in non-navigation seasons by increasing infiltration and reducing the amount of water taken from storage in the aquifer. However, if the dredging enlarges the cross-section area of the riverbed significantly, such enlargement might serve to increase the rate of silt accumulation by reducing river velocity. In this event the benefits of dredging would be short lived.

In considering the possibility of concentrating future pumping closer to the river than at present, the resulting shorter travel time and flow paths from the river to the wells may permit polluted water from the river to reach the wells. However, the pollution can probably be treated adequately and, hence, may not be a significant problem.

QUALITY OF WATER

CHEMICAL QUALITY

Ground water in eastern Schenectady County is hard and has a wide range in the amount of dissolved mineral constituents. Chemical analyses of water from wells and springs in the area and from the Mohawk River are shown in table 5. The source, or cause, and the significance of the principal mineral constituents and physical properties of the water are shown in table 6.

The median value and the range of concentration of several of the mineral constituents and the physical characteristics of representative samples of ground water from different types of aquifers in eastern Schenectady County are shown in table 7. It will be noted that the range for a given mineral constituent or physical characteristic of the water from one type of aquifer overlaps the range of concentration in water from the other types of aquifers. The overlap is due, in part, to a similarity in the chemical composition of the different rock materials, but it is also related to the composition of other materials through which the water has moved enroute to the sampling point, and the length of time it was in contact with each. Thus, water from a sand and gravel lens in till may be more representative of the water in the till than it is of water from the average sand and gravel deposit.

The water from wells in the Schenectady Shale is the most mineralized of the waters sampled. Water from well 251-401-8, which is 463 feet deep, had a specific conductance of 29,300 micromhos. However, the median specific conductance of water from other, less deep, wells in shale was 780 micromhos with a range of 268 to 2,350 micromhos. The median chloride content of water from shale is more than twice that of water from the unconsolidated materials. The median bicarbonate content of water from shale is 313 ppm, but the median total hardness as $CaCO_3$ is only 176 ppm, which indicates that metallic ions other than calcium and magnesium are present in the water to combine with the bicarbonate ions.

The range of mineralization of water from the unconsolidated deposits is less than that of the shale. The median bicarbonate in water from till is 240 ppm, whereas the average total hardness is 284 ppm, which indicates that part of the hardness of water from till is noncarbonate hardness. The hardness of waters from sand and from sand and gravel is essentially all bicarbonate hardness. This is indicated by the similar values of total hardness and the bicarbonate content of the waters. The median pH of ground waters from the several types of materials is similar, 7.2 to 7.8, but the range is greatest in waters from shale. The water from many wells in shale is reported to contain objectionable amounts of hydrogen sulfide gas (H_2S). A strong odor is imparted by less than 1 ppm H_2S in water.

Table 5.--Chemical analyses of ground water and Mohawk River water in eastern Schenectady County

(Dissolved mineral constituents given in parts per million)

Well number: See "Well-Numbering System" in text for explanation.

Depth of well: All depths below land surface; r, reported depth; all other depths measured.

Water-bearing material: Cl, clay; Si, silt; S, sand; G, gravel; T, till; Sh, shale.

Dissolved solids: Residue on evaporation at 180°C in analyses by U.S. Geological Survey.

Remarks: a, analysis by U.S. Geological Survey, Water Resources Division; b, analysis by New York State Department of Health. Sn, well number in Bulletin GW-30; CS, City of Schenectady well number; TR, Town of Rotterdam well number.

Abbreviations: t, combined total for sodium and potassium.

Well Number	Depth of Well (feet)	Water-Bearing Material	Date of Collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (as $CaCO_3$) Calcium, Magnesium	Noncarbonate	Specific Conductance (Micromhos at 25°C)	pH	Color	Remarks
246-349-2	r60	Sh	4/18/46	--	0.3	0.3	--	--	--	--	418	211	2.2	--	--	836	540	197	--	7.1	25	b; Sn 151.
246-357-1	r15	S	5/29/45	--	.1	--	--	--	--	--	71	--	3.2	--	1.4	--	72	14	--	8.4	--	b; Sn 29.
-2	r307	Sh	9/ 6/45	--	2.5	.00	--	--	--	--	505	50	195	--	--	945	8	0	--	9.1	5	b; Sn 30.
247-350-5	85	Sh	8/ 4/59	--	--	--	--	--	--	--	--	--	52	--	--	--	--	--	961	--	--	a.
247-351-1	10	S	8/ 4/59	--	--	--	--	--	--	--	195	--	4.0	--	--	--	300	140	570	--	--	a.
247-358-1	r302	Sh	8/23/45	--	.8	<.01	--	--	--	--	249	1	46	--	--	324	1	0	--	6.8	15	b; Sn 27.
-2	r40	S	8/23/45	--	1.0	<.01	--	--	--	--	189	18	2.0	--	--	274	140	0	--	8.1	0	b; Sn 28.
248-351-2	r130	Sh	8/14/59	--	--	--	--	--	--	--	615	--	52	--	--	--	17	0	1,050	9.2	--	a; bicarbonate includes equivalent of 80 ppm carbonate (CO_3).
-3	19	T or S,Si	8/ 4/59	--	--	--	--	--	--	--	--	--	38	--	--	--	--	--	648	--	--	a.
248-352-1	14	T	7/31/59	--	--	--	--	--	--	--	--	--	15	--	--	--	--	--	495	--	--	a.
-2	r96	Sh	10/19/48	15	.38	--	57	17	28	1.8	229	68	8.5	0.3	1.0	301	212	24	508	7.3	3	a; Sn 282.
-3	40	Sh	11/ 9/49	--	.55	--	--	--	--	--	152	2	4.0	.1	.1	--	92	0	246	7.7	--	a; Sn 284.
248-358-1	14	S,G	9/ 1/59	--	--	--	--	--	--	--	--	--	35	--	--	--	--	--	475	--	--	a.
248-359-1	14	S	10/16/59	--	--	--	--	--	--	--	--	--	76	--	--	--	--	--	1,040	--	--	a.
-9	r84	S	8/24/61	--	.35	.5	--	--	--	--	--	--	8.2	--	--	--	172	--	--	--	--	a.
248-400-1	r105	Sh	9/16/59	--	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--	504	--	--	a.
-2	27	Sh	9/16/59	--	--	--	--	--	--	--	--	--	24	--	--	--	--	--	675	--	--	a.
-3	14	T	9/18/59	--	--	--	--	--	--	--	428	--	5.8	--	--	--	508	158	912	7.2	--	a.
-4	r100	S,G	7/31/58	--	.2	--	--	--	--	--	--	--	10	--	.04	--	390	--	--	7.4	0	b.
-5	r172	Sh	10/ 8/59	--	.06	--	--	--	--	--	--	--	32	--	.04	--	330	--	--	7.2	0	b.

Table 5.--Chemical analyses of ground water and Mohawk River water in eastern Schenectady County (Continued)

Well Number	Depth of Well (feet)	Water-Bearing Material	Date of Collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (as $CACO_3$) Calcium, Magnesium	Hardness (as $CACO_3$) Noncarbonate	Specific Conductance (Micromhos at 25°C)	pH	Color	Remarks
248-400-6	r184	Sh	4/25/61	--	0.34	--	--	--	--	--		--	37	--	0.04	--	310	--	--	7.5	0	b.
248-401-1	98	Sh	8/19/59	--	--	--	--	--	--	--	562	--	440	--	--	--	22	0	2,350	8.9	--	a.
248-402-1	65	Sh	11/ 8/45	--	.2	.00	--	--	--	--	371	57	3.8	--	--	423	140	0	--	7.7	0	b; Sn 119.
249-353-2	15	T	7/30/59	--	--	--	--	--	--	--	--	--	15	--	--	--	--	--	524	--	--	a.
249-358-1	32	S,G	7/28/59	--	--	--	--	--	--	--	--	--	16	--	--	--	--	--	757	--	--	a.
249-359-2	35	S	11/24/48	--	--	--	--	--	--	--		--	--	--	--	--	320	--	--	--	--	b; Sn 26.
-16	69	S	8/24/61	--	.05	.1	--	--	--	--	--	--	9.6	--	--	--	165	--		--	--	a.
-16	69	S	9/ 1/59	--	--	--	--	--	--	--	--	--	7.8	--	--	--	--	--	321	--	--	a.
-17	55	Sh	9/16/59	--	--	--	--	--	--	--	--	--	28	--	--	--	--	--	987	--	--	a.
-18	--	S	9/16/59	--	--	--	--	--	--	--	--	--	7.2	--	--	--	--	--	392	--	--	a; developed spring.
-19	--	S	9/16/59	--	--	--	--	--	--	--	--	--	2.0	--	--	--	--	--	260	--	--	a.
-25	202	Sh	12/18/59	--	--	--	--	--	--	--	582	--	188	--	--	--	10	--	1,510	9.0	--	a; bicarbonate includes equivalent of 63 ppm carbonate (CO_3).
-26	50	S,G	10/24/60	--	1.7	.61	--	--	--	1.6	--	29	10	--	.1	--	--	--	344	7.8	--	a; 0.1 ppm dissolved oxygen.
-33	63	S,G	10/24/60	--	.87	.7	--	--	--	1.2	--	30	9.3	--	.2	--	--	--	365	7.8	--	a; 0.2 ppm dissolved oxygen.
-36	33	G	10/24/60	--	.46	.05	--	--	--	1.5	--	28	10	--	.1	--	--	--	318	7.8	--	a; 0.4 ppm dissolved oxygen.
-75	67	G	8/ 9/61	--	.02	.0	--	--	--	--	--	--	8.9	--	--	--	164	--	--	--	--	a; CS 1; Sn 129.
-76	r62	G	9/23/48	6.5	.05	--	49	8.6	7.4	1.8	158	30	7.2	.1	.3	187	155	30	331	7.7	3	a; CS 2; Sn 130.
-78	r71	G	10/24/60	--	.1	.08	--	--	--	1.7	--	33	9.6	--	.2	--	--	--	363	7.5	--	a; CS 4; Sn 132.
-79	r62	G	8/22/47	6.0	.09	.13	46	7.5	t4.4		152	23	4.4	.1	.3	173	146	21	--	7.7	--	a; CS 5; Sn 133.
-80	r57	G	10/ 5/46	--	.03	.05	--	--	--	--	159	1	8.6	<.05	--	195	148	18	--	7.7	0	b; CS 6; Sn 134.
-84	r66	G	10/24/60	--	.04	.59	--	--	--	1.6	--	35	9.5	--	.1	--	--	--	395	7.6	--	a; 0.2 ppm dissolved oxygen; CS 10; Sn 138.
-91	r82	G	11/15/60	--	.06	--	--	--	--	--	--	--	11	--	.16	--	180	--	--	7.7	0	b; TR 1; Sn 334.

Table 5.--Chemical analyses of ground water and Mohawk River water in eastern Schenectady County (Continued)

Well Number	Depth of Well (feet)	Water-Bearing Material	Oate of Collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride	Nitrate (NO_3)	Dissolved solids	Hardness (as $CACO_3$) Calcium, Magnesium	Hardness (as $CACO_3$) Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color	Remarks
249-359-92	r82	G	11/15/60	--	0.02	--	--	--	--	--	--	--	12	--	.44	--	196	--	--	7.6	0	b; TR 2; Sn 339.
-93	r81	G	11/15/60	--	.02	--	--	--	--	--	--	--	11	--	.48	--	184	--	--	7.7	0	b; TR 3; Sn 340.
-94	r69	G	8/ 9/61	--	.01	.6	--	--	--	--	--	--	9.1	--	--	--	203	--	--	--	--	a; CS 11; Sn 359.
-95	r71	G	8/ 9/61	--	.00	.0	--	--	--	--	--	--	8.6	--	--	--	166	--	--	--	--	a; CS 12; Sn 360.
-97	r44	G	6/ 1/28	--	--	--	--	--	--	--	--	--	5.5	--	.85	--	119	--	--	--	--	Analysis by city of Schenectady; Sn 127.
249-400-3	r201	G,Sh	10/ 1/56	--	.1	--	--	--	--	--	370	--	9.2	--	.16	--	430	--	--	7.4	0	b.
250-352-1	12	S,Sh	7/31/59	--	--	--	--	--	--	--	--	--	15	--	--	--	--	--	236	--	--	a.
250-353-1	r115	Sh	7/30/59	--	--	--	--	--	--	--	--	--	52	--	--	--	--	--	946	--	--	a.
-3	17	T	7/30/59	--	--	--	--	--	--	--	--	--	3.8	--	--	--	--	--	288	--	--	a.
-4	11	T	7/30/59	--	--	--	--	--	--	--	--	--	100	--	--	--	--	--	1,000	--	--	a.
250-354-2	12	T	7/30/59	--	--	--	--	--	--	--	--	--	5.5	--	--	--	--	--	147	--	--	a.
250-355-3	4	T	7/16/59	--	--	--	--	--	--	--	--	--	2.8	--	--	--	--	--	427	--	--	a.
-4	19	S,G	7/16/59	--	--	--	--	--	--	--	--	--	4.6	--	--	--	--	--	378	--	--	a.
250-356-3	12	S,G	7/14/59	--	--	--	--	--	--	--	--	--	17	--	--	--	--	--	480	--	--	a.
-4	21	S,G	7/15/59	--	--	--	--	--	--	--	--	--	13	--	--	--	--	--	475	--	--	a.
-5	21	S,G	7/15/59	--	--	--	--	--	--	--	--	--	16	--	--	--	--	--	435	--	--	a.
-7	25	S	7/15/59	--	--	--	--	--	--	--	--	--	26	--	--	--	--	--	506	--	--	a.
250-357-3	10	Sh	7/14/59	--	--	--	--	--	--	--	--	--	5.5	--	--	--	--	--	268	--	--	a.
-4	32	Sh	7/14/59	--	--	--	--	--	--	--	--	--	5.4	--	--	--	--	--	583	--	--	a.
-5	r40	Sh	7/14/59	--	--	--	--	--	--	--	--	--	3.5	--	--	--	--	--	371	--	--	a.
250-358-2 & 10	r70 &r85	S & S,G	5/26/43	--	<.03	--	--	--	--	--	137	--	3.0	--	--	--	128	16	--	7.5	0	b; Sn 4, Sn 5.
-9	r202	S,G	4/ 9/45	--	1.1	--	--	--	--	--	239	--	6.0	--	--	--	230	34	--	7.5	0	b; Sn 1.

Table 5.--Chemical analyses of ground water and Mohawk River water in eastern Schenectady County (Continued)

Well Number	Depth of Well (feet)	Water-Bearing Material	Date of Collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (as $CACO_3$) Calcium, Magnesium	Hardness (as $CACO_3$) Noncarbon te	Specific Conductance (Micromhos at 25°C)	pH	Color	Remarks
250-359-3	4	T,Sh	6/30/59	--	--	--	--	--	--	--	--	--	13	--	--	--	--	--	654	--	--	a.
-6	r57	S	7/28/59	--	--	--	--	--	--	--	--	--	23	--	--	--	--	--	1,080	--	--	a.
-7	22	S,G	7/28/59	--	--	--	--	--	--	--	--	--	19	--	--	--	--	--	692	--	--	a.
250-400-10	35	S,G	9/15/59	--	--	--	--	--	--	--	--	--	73	--	--	--	--	--	640	--	--	a.
251-353-1	21	T	7/17/59	--	--	--	--	--	--	--	--	--	198	--	--	--	--	--	1,280	--	--	a.
251-354-1	r26	S	7/16/59	--	--	--	--	--	--	--	--	--	10	--	--	--	--	--	376	--	--	a.
-3	4	S	7/16/59	--	--	--	--	--	--	--	--	--	2.1	--	--	--	--	--	192	--	--	a.
-5	21	Sh	7/16/59	--	--	--	--	--	--	--	--	--	24	--	--	--	--	--	644	--	--	a.
-7	11	S	7/17/59	--	--	--	--	--	--	--	--	--	43	--	--	--	--	--	669	--	--	a.
-11	24	S	7/17/59	--	--	--	--	--	--	--	--	--	19	--	--	--	--	--	566	--	--	a.
-12	r69	Sh	11/10/59	--	0.16	--	--	--	--	--	--	--	2.0	--	0.10	--	24	--	--	8.7	0	b.
-13	r65	S,G	7/18/60	--	.04	--	--	--	--	--	--	--	2.0	--	.02	--	136	--	--	7.8	0	b.
251-355-3	r150	Sh	8/26/47	12	.55	0	69	19	t 19		259	62	9.8	0.1	.4	325	250	38	--	7.3	6	a; Sn 11.
251-356-1	15	S	7/ 2/59	--	--	--	--	--	--	--	--	--	67	--	--	--	--	--	728	--	--	a.
-11	r80	S,G	9/ 4/57	--	.5	--	--	--	--	--	341	--	4.6	--	.96	--	310	--	--		0	b.
251-357-1	25	S,G	7/ 2/59	--	--	--	--	--	--	--	--	--	8.2	--	--	--	--	--	298	--	--	a.
-2	19	Sh	7/ 1/59	--	--	--	--	--	--	--	--	--	28	--	--	--	--	--	631	--	--	a.
-7	r30	S	5/23/61	--	.66	0.15	--	--	--	--	--	--	4.2	--	.02	--	192	--	--	7.5	20	b.
251-358-1	8	T	6/30/59	--	--	--	--	--	--	--	--	--	20	--	--	--	--	--	538	--	--	a; developed spring.
-2	22	T	6/30/59	--	--	--	--	--	--	--	--	--	31	--	--	--	--	--	540	--	--	a.
-3	16	Sh	6/30/59	--	--	--	--	--	--	--	--	--	159	--	--	--	--	--	1,060	--	--	a.
-4	10	T	6/30/59	--	--	--	--	--	--	--	--	--	11	--	--	--	--	--	423	--	--	a.
-5	31	T	6/30/59	--	--	--	--	--	--	--	--	--	51	--	--	--	--	--	983	--	--	a.

Table 5.--Chemical analyses of ground water and Mohawk River water in eastern Schenectady County (Continued)

Well Number	Depth of Well (feet)	Water-Bearing Material	Date of Collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (as $CACO_3$) Calcium, Magnesium	Hardness (as $CACO_3$) Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color	Remarks
251-358-6	--	T	7/ 7/59	--	--	--	--	--	--	--	--	--	44	--	--	--	--	--	491	--	--	a, developed spring.
-8	28	T	7/ 1/59	--	--	--	--	--	--	--	--	--	20	--	--	--	--	--	632	--	--	a.
-10	82	Sh	7/23/59	--	5.0	--	--	--	--	--	--	--	7	--	0.26	--	2	--	--	8.9	10	b.
-11	22	Sh	7/ 1/59	--	--	--	--	--	--	--	--	--	88	--	--	--	--	--	780	--	--	a.
251-359-5	22	S,G	6/30/59	--	--	--	--	--	--	--	--	--	4.7	--	--	--	--	--	274	--	--	a.
-6	r40	S,G	6/30/59	--	--	--	--	--	--	--	--	--	3.4	--	--	--	--	--	301	--	--	a.
-7	r21	T	7/ 2/59	--	--	--	--	--	--	--	--	--	55	--	--	--	--	--	997	--	--	a.
-8	20	Sh	7/ 2/59	--	--	--	--	--	--	--	--	--	14	--	--	--	--	--	318	--	--	a.
251-400-10	r325	Sh	7/29/59	--	--	--	--	--	--	--	--	--	75	--	--	--	--	--	765	--	--	a.
251-401-8	r463	Sh	10/30/50	22	43	0.4	1,190	576	6,120	296	5,050	0	10,800	3.0	1.6	21,700	5,340	--	29,300	6.2	1	a; Sn 337.
-11	51	S,G	1/ 9/58	--	.08	--	--	--	--	--	192	--	6	--	1.5	--	220	--	--	7.7	0	b.
-19	r321	Sh	5/17/45	--	.5	--	--	--	--	--	809	--	180	--	.02	--	80	0	--	8.0	--	b; Sn 191.
252-354-5 & 6	13,r17	S,G	4/24/61	--	.2	.02	--	--	--	--	--	--	14	--	.36	--	260	--	--	7.4	0	b.
252-355-10	r9	Si,Cl	9/19/60	--	.08	<.01	--	--	--	--	--	--	25	--	3.0	--	172	--	--	7.9	0	b.
252-356-8	r22	S,G,Sh	11/ 2/61	--	.26	.2	--	--	--	--	--	--	40	--	.02	--	320	--	--	7.3	10	b.
-9	r24	S,G,Sh	11/ 2/61	--	4.3	.35	--	--	--	--	--	--	35	--	.02	--	330	--	--	7.4	0	b.
-10	r24	S,G,Sh	11/ 2/61	--	4.2	.3	--	--	--	--	--	--	34	--	.02	--	410	--	--	7.3	3	b.
-11	r24	S,G,Sh	11/ 2/61	--	3.5	.2	--	--	--	--	--	--	50	--	.02	--	410	--	--	7.5	5	b.
252-357-1	11	T	7/ 1/59	--	--	--	--	--	--	--	--	--	12	--	--	--	--	--	566	--	--	a.
-2	11	T	7/ 1/59	--	--	--	--	--	--	--	--	--	2.6	--	--	--	--	--	440	--	--	a.
-4	9	Sh	7/ 2/59	--	--	--	--	--	--	--	--	--	89	--	--	--	--	--	806	--	--	a.
252-402-4	6	S,G	7/29/59	--	--	--	--	--	--	--	--	--	11	--	--	--	--	--	338	--	--	a.
-16	r63	S,G	12/ 7/60	--	.08	--	--	--	--	--	--	--	27	--	6.5	--	310	--	--	7.5	0	b; Sn 229.

Table 5.--Chemical analyses of ground water and Mohawk River water in eastern Schenectady County (Continued)

Well Number	Depth of Well (feet)	Water-Bearing Material	Date of Collection	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (CO_3) Calcium, Magnesium	Hardness (CO_3) Noncarbonate	Specific Conductance (Micromhos at 25°C)	pH	Color	Remarks
252-403-4	35	S,G	7/29/59	--	--	--	--	--	--	--	--	--	15	--	--	--	--	--	454	--	--	a.
253-354-4	12	T	8/ 7/59	--	--	--	--	--	--	--	221	--	18	--	--	--	262	81	497	--	--	a.
-5	16	T	8/ 7/59	--	--	--	--	--	--	--	240	--	27	--	--	--	284	87	538	--	--	a.
253-402-3	15	G	8/23/45	--	.1	<.01	--	--	--	--	113	64	4.6	--	--	264	132	39	--	7.3	0	b; Sn 139.
253-404-12	r133	G	8/23/45	--	.8	.05	--	--	--	--	178	25	.8	--	--	222	120	0	--	8.3	10	b; Sn 93.
254-354-3	16	T	9/17/59	--	--	--	--	--	--	--	--	--	7.6	--	--	--	--	--	539	--	--	a.
254-355-5	--	Si	9/17/59	--	--	--	--	--	--	--	--	--	8	--	--	--	--	--	380	--	--	a; developed spring.
255-401-4	12	S	6/26/46	--	.5	.25	--	--	--	--	173	36	9.6	--	--	273	172	30	--	7.2	10	b; Sn 205.
255-404-4	18	Sh	6/26/46	--	.5	<.01	--	--	--	--	322	93	44	--	--	648	370	106	--	7.0	10	b; Sn 199.
Mohawk River 1/			10/24/60	--	.26	.10	--	--	--	1.7	--	31	15	--	1.2	--	--	--	283	8.3	--	a; 11.0 ppm dissolved oxygen; below dam at surface.
Do.			10/24/60	--	.16	.03	--	--	--	1.8	--	32	15	--	1.2	--	--	--	283	8.2	--	a; 10.7 ppm dissolved oxygen; below dam at river bottom.
Do.			10/24/60	--	.19	.09	--	--	--	1.7	--	30	15	--	1.2	--	--	--	284	8.0	--	a; 10.4 ppm dissolved oxygen; above dam at surface.
Do.			10/24/60	--	.18	.04	--	--	--	1.7	--	30	15	--	1.2	--	--	--	283	8.0	--	a; 10.5 ppm dissolved oxygen; above dam at river bottom.
Do.			3/21/61	--	.11	.1	--	--	--	--	--	--	7.8	--	--	--	102	--	221	--	--	a; above dam at surface.

1/ Mohawk River at Lock 8, N. Y. S. Barge Canal.

Table 6.--Source, or cause, and significance of the principal mineral constituents and physical properties of water

Constituent of property	Source of cause	Significance
Silica (SiO_2)	Dissolved from practically all rocks.	Contributes to the formation of boiler scale. Inhibits solution of silica from zeolite in water softeners.
Iron (Fe) and Manganese (Mn)	Dissolved from practically all rocks. Natural waters contain five to ten times as much iron as manganese.	May cause staining of clothes and of porcelain or enameled fixtures. Iron and manganese become objectionable when concentrations exceed 0.3 ppm and 0.05 ppm, respectively 1/.
Calcium (Ca) and Magnesium (Mg)	Dissolved from practically all rocks, but especially from limestone and dolomite, or deposits containing limestone or dolomite particles.	Principal cause of water hardness and the formation of boiler scale.
Sodium (Na) and Potassium (K)	Dissolved from practically all rocks. Present in sewage and industrial wastes.	Large amounts in combination with chlorine cause foaming in boilers. Increases the corrosiveness of water and gives water a salty taste.
Bicarbonate (HCO_3) and Carbonate (CO_3)	Occurs in natural water largely through the action of carbon dioxide in water on carbonate rocks such as limestone and dolomite. Carbonate usually is not present in natural waters.	Produces alkalinity and in combination with magnesium and calcium causes carbonate hardness. Decomposes in boilers to form scale and to release corrosive carbon dioxide gas.
Sulfate (SO_4)	Dissolved from rocks, especially those containing gypsum, iron sulfides and other sulfur compounds.	Sulfate in water that contains calcium and magnesium causes the formation of hard scale in steam boilers. USPHS standards suggest sulfate be less than 250 ppm in drinking water 1/.
Chloride (Cl)	Dissolved from rocks. Present in sewage and industrial wastes.	Large amounts in combination with sodium and potassium causes foaming in boilers and increases the corrosiveness of water. Imparts a salty taste to water when the sodium chloride content in terms of chloride exceeds about 250 ppm 1/.
Fluoride (F)	Dissolved from rocks, but present in natural waters in very small quantities.	Fluoride in water in concentrations of about 1 ppm decreases the incidence of dental caries when consumed by children during the calcification or formation of teeth. However, when water exceeding 1.5 ppm fluoride is consumed by children permanent staining of teeth may result 2/. USPHS standards suggest fluoride not exceed 1.5 ppm 1/.
Nitrate (NO_3)	Source largely is sewage and decaying organic material.	Presence in natural water in concentrations greater than 10 ppm indicates pollution. Water containing nitrate in excess of 45 ppm should not be used in baby feeding 1/ and 3/.
Dissolved solids	Consists principally of dissolved mineral constituents in the water, but includes organic matter and some water of crystallization when dehydration is complete (residue after evaporation).	USPHS drinking water standards recommend that dissolved solids not exceed 500 ppm 1/. Water containing more than 1,000 ppm dissolved solids is unsuitable for many purposes.
Hardness	Principally caused by calcium and magnesium, but includes hardness caused by other metallic ions.	Soap is consumed by the metallic cations. No lather is produced until the amount of soap exceeds that required to combine with the metallic cations. The hardness caused by carbonate or bicarbonate of calcium and magnesium is called carbonate hardness and hardness in excess of this quantity is called noncarbonate hardness. Use of Calgon or other water softeners reduces the amount of soap required to produce a lather. Water having a hardness of less than 100 ppm is considered soft and usually does not prove objectionable for domestic use. However, most natural ground waters have a hardness of 200 to 300 ppm. Hard water requires either an excessive amount of soap, use of water softeners in conjunction with soap, or use of synthetic detergents.
Specific conductance	Electrical conductivity of water.	Reflects the concentration and degree of mineralization of mineral constituents in water. Varies with mineralization and temperature.
pH	Free acids, acid generating salts, and dissolved gases lower the pH. Carbonate, bicarbonate, and hydroxide raise the pH.	A solution is neutral if the pH is 7.0. Values higher than 7.0 indicate alkalinity and values lower than 7.0 indicate acidity. Generally water becomes increasingly more corrosive as the pH decreases, but excessively alkaline water may be corrosive also.
Color	The color of natural water free of suspended solids is caused primarily by organic material from decaying plants, and by sewage and industrial wastes.	Makes water unpalatable or otherwise objectionable. USPHS drinking water standards suggest that color be below 20 units for drinking water 1/.

1/ U. S. Public Health Service, 1962, Drinking water standards: Federal Register, March 6, p. 2152-2155.
2/ Dean, H. T., 1936, Chronic endemic dental fluorosis: Am. Med. Assoc. Jour., v. 107, p. 1269-72.
3/ Waring, F. H., 1949, Significance of nitrates in water supplies: Am. Water Works Assoc. Jour., v. 72, no. 2.

Table 7.--Summary of selected chemical constituents and physical properties of ground water in the various aquifers

Water-bearing material		Specific conductance (micromhos)	Chloride (ppm)	Bicarbonate (ppm)	Total hardness as $CaCO_3$ (ppm)	pH
Shale	Median	780	38	313	176	7.5
	Range	268-2,350	3.5-440	152-809	1-540	6.2-9.1
	Samples	19	19	20	18	19
Till	Median	531	14	240	284	
	Range	147-1,000	2.6-100	221-428	262-508	
	Samples	18	18	3	3	1
Sand	Median	506	15	192	172	7.8
	Range	192-1,080	2.0- 76	71-310	72-320	7.2-8.4
	Samples	13	13	4	7	4
Sand and gravel	Median	464	15.5	177	176	7.7
	Range	274- 757	3.4- 73	113-345	119-390	7.2-8.3
	Samples	14	14	20	24	23

The hardness of water in the Mohawk River in the project area ranges from about 50 to 125 ppm (Simpson, 1952, fig. 27; Simpson and others, 1959, table 2) and is subject to seasonal variation. It is higher than average in late summer and early fall during the period of low streamflow when the percentage of ground-water runoff in river water is higher than at other times of the year.

Water from a stream infiltration supply is usually intermediate between the river water and local ground water in the amounts of dissolved mineral constituents. When the wells at the Schenectady well field were first drilled (1942-43) the water pumped from them during performance tests had an average hardness of about 230 ppm (Simpson, 1952, table 19) and this water was representative only of ground water which had been moving very slowly through this part of the aquifer. In 1948, after the well field had been in regular service for 4 years, the water from the wells had an average hardness of about 145 ppm. At that time the water moving through the aquifer was primarily infiltrated river water which had increased in mineral content during transit from the river to the wells.

Many samples of water were also analyzed for iron and manganese during this investigation as these constituents commonly cause problems of taste, color, or staining in water supplies. The data in table 5 show that 19 water samples from wells in shale and 28 from wells in sand and gravel contained iron. In these samples 73 percent of the 19 from the shale and 32 percent of the 28 sand and gravel contained more than the U.S. Public Health Service (1962) recommended maximum of 0.3 ppm iron. In samples analyzed for manganese, 55 percent of the 11 samples from shale and 58 percent of the 19 samples from sand and gravel contained more than the recommended maximum of 0.05 ppm. Both iron and manganese are native constituents

of the shale bedrock. The sand and gravel contains a substantial portion of locally derived stone which undoubtedly contributes directly to concentrations of these ions in water from such deposits. Additionally, organic matter in the unconsolidated deposits fosters solution of these minerals, especially manganese. The likely presence of iron and manganese-fixing bacteria, and the reducing (low oxygen content) environment of water in flood-plain and channel deposits also fosters solution of the iron and manganese and their redeposition upon aeration.

The manganese concentration in ground water is usually only a fraction of the iron concentration (Hem, 1959, p. 68). However, water from wells in the well field area, especially at the southern end of the Schenectady well field, contains many times more manganese than iron although Mohawk River water is essentially free of manganese. A sample of water from well 249-359-94 (table 5) contained 0.01 ppm iron and 0.6 ppm manganese. It is believed that the high concentration of manganese is partly due to its solution from organic materials (tree stumps, logs, etc.) incorporated in the flood-plain deposits.

TEMPERATURE OF GROUND WATER

Ground water in natural transit between a point of recharge and a point of discharge has a small annual variation of temperature, the average of which is a few degrees above the annual mean air temperature (47.2°F at Schenectady) (Collins, 1925, p. 97). The temperature of ground water was measured periodically on the flood plain of the Mohawk River in areas where the effect of floods and stream infiltration was not appreciable. In 1960 and 1961 the temperature of ground water varied from 47.7°F to 50.5°F in well 249-359-21, from 47.2°F to 50.0°F in well 249-359-33, and from 45°F to 49°F in well 250-400-3. The average annual range of ground-water temperature is, thus, about 3°F in these wells. The temperature of water in well 249-359-21 during the year ending July 31, 1961, is shown in figure 21. Water pumped from well 249-359-25, drilled in shale from 73 to 202 feet below land surface, had a temperature on December 18, 1959, of 50.0°F. Water flowing from well 251-401-8, drilled in shale from a depth of 244 feet to a depth of 463 feet, had a temperature of 52.5°F on June 26, 1959.

When ground-water temperature varies more than about 5°F annually, either the point of temperature measurement is near the land surface, or recharge occurs so rapidly that ground-water temperature reflects the seasonal variation in temperature of the recharging water. The source of such recharge may be precipitation, stream infiltration, or artificial recharge through nearby wells. Theoretically, in areas of stream infiltration ground-water temperatures could vary annually almost as much as river-water temperatures. However, infiltrated river water usually is mixed with warmer or colder water already in the aquifer. Thus, the annual variation of the temperature of water in an aquifer supplied by infiltration is less than that of the river because of heat exchange. In the Schenectady and Rotterdam well field area, the maximum annual variation of ground-water temperatures was only about 30°F as compared with the annual variation of about 45°F for Mohawk River water. (See section entitled, "Relationship of river temperature to water temperature in the aquifer.")

CONTAMINATION OF GROUND-WATER SUPPLIES BY FALLOUT PRODUCTS

Opportunity to study the possible contamination of the aquifer at the Schenectady well field by fallout from nuclear explosions was afforded by the resumption of nuclear weapons testing by the U.S.S.R. in early September 1961. The method of study was to analyze the tritium content of water from one of the pumping wells at the Schenectady well field (well 249-359-75) and compare it with the beta radioactivity of water in the Mohawk River. Both the tritium and beta radioactivity reflect fallout with precipitation over the Mohawk River basin.

Tritium is the isotope of hydrogen of mass 3, as compared to hydrogen with a mass of 1, and deuterium with a mass of 2. Tritium does not occur naturally in water in concentrations of more than 10 T. U. (tritium units) which is the equivalent of the ratio of 10 tritium atoms to 1 X 10^{18} hydrogen (protium) atoms (von Buttlar and Wendt, 1958, p. 661, 663; von Buttlar, 1959, p. 1031). The natural occurrence of tritium results from the bombardment of atoms in the upper atmosphere by cosmic rays. However, large amounts of tritium are produced artificially by hydrogen bomb explosions, hence, concentrations in excess of 10 T. U. indicate contamination by fallout from such explosions. Tritium is a very weak emitter of beta particles. The behavior of water containing tritium is no different than ordinary water because water molecules have the same characteristics with respect to movement through the ground whether the atoms are hydrogen, deuterium, or tritium isotopes.

However, some of the other fallout substances, that are responsible for the high beta radioactivity in the river water, can be removed to differing degrees by ion exchange with the riverbed materials and the aquifer as the water moves through them. Hence, beta radioactivity in the ground water cannot be reliably compared directly with that in the river because of the variables. Beta radioactivity is measured as micromicrocuries per liter, or the equivalent, pica-curies per liter (pc/l). Periodic samples of tap water at the Knolls Atomic Power Laboratory, which is supplied by water from the city of Schenectady, did not contain notable beta radioactivity between September 1961 and the end of January 1962 (M. R. Kennedy, Biochemist, Knolls Atomic Power Laboratory, oral communication, 1962).

FALLOUT PRODUCTS IN INFILTRATION SUPPLIES

During the moratorium on nuclear-weapons testing between 1959 and September 1, 1961, the tritium content of rainfall in North America declined and during the summer of 1961 leveled out to an average range of 40-50 T. U. (Thatcher, 1962, p. 49). Therefore, it was thought that any increase in the tritium content of water from the Schenectady well field above this amount during the fall of 1961 and the winter of 1961-62 could be considered the result of the U.S.S.R. thermonuclear test series that began September 1, 1961, and the United States test series that began shortly thereafter. The time between peak concentrations of the amount of tritium in water from the well field at different times, and corresponding peaks of beta radioactivity of Mohawk River water, would indicate the time required for water to move from the river to the well fields.

Water samples were collected from the Mohawk River about a mile below the well fields by continuous composite sampling methods from September 4, 1961 through January 1962. A 7-day composite sample of river water was taken each week, and the beta radioactivity measured, by the Knolls Atomic Power Laboratory of the U.S. Atomic Energy Commission as a part of that agency's monitoring program. Samples of ground water were collected from well 249-359-75 every two weeks during the same period. These were analyzed for tritium by the Quality of Water Branch, U.S. Geological Survey, Washington, D. C., and they provided information on tritium content of the well water only on the date of collection. The data obtained by these methods are plotted in figure 31.

The first peak of radioactivity in the river water occurred during the week ending September 25, 1961. The first apparent tritium peak (point A, fig. 31) in the ground water occurred in early October and is represented by the tritium concentration of 133 T. U. on October 9, 1961. The actual peak may have been higher than 133 T. U. and it may have occurred a few days before or after October 9. (The tritium content of river water on September 25 was 144 T. U.) The elapsed time between the midpoint of the beta peak activity and the apparent tritium peak is about 18 days. This is considerably less than the travel time of 26 days established for this well on the basis of temperature data and shown in figure 26. This difference in travel time may be due to the lack of assurance as to the exact date of the tritium peak.

It must be noted here that tritium and beta activity levels in the river may rise very sharply and rapidly at a given sampling point if the transporting rainfall is very local. However, because of the travel time required for the arrival of water from distant parts of the drainage basin to the sampling point, the loss of beta activity due to ion exchange in transit, and dilution due to mixing in transit through the aquifer, the duration of the tritium peaks in the ground water may be longer and more subdued than correlative peaks in the river.

For these reasons, if a peak period in the river is followed by a rapid recession and an extended period of only normal concentrations, the correlative concentration in the aquifer will decline until it also reaches a low normal level or until a new and higher concentration in infiltrated water arrives at the sampling point. Thus, in some instances as shown in figure 31, a beta activity peak in the river may occur at the same time as a low point in the tritium concentration in the aquifer. In figure 31 the suggested points of correlation in the beta activity and tritium records are indicated by like letter symbols. The apparent travel time from river to well (measured from midpoint of the 7-day river sampling period to the tritium sampling date) are:

A - 17 days
B - 17 days
C - 24 days
D - 24 days
E - 32 days
F - 17 days

This apparent range in travel time of water from the river to the well is, in part, due to the composite nature of the river samples and to the length of

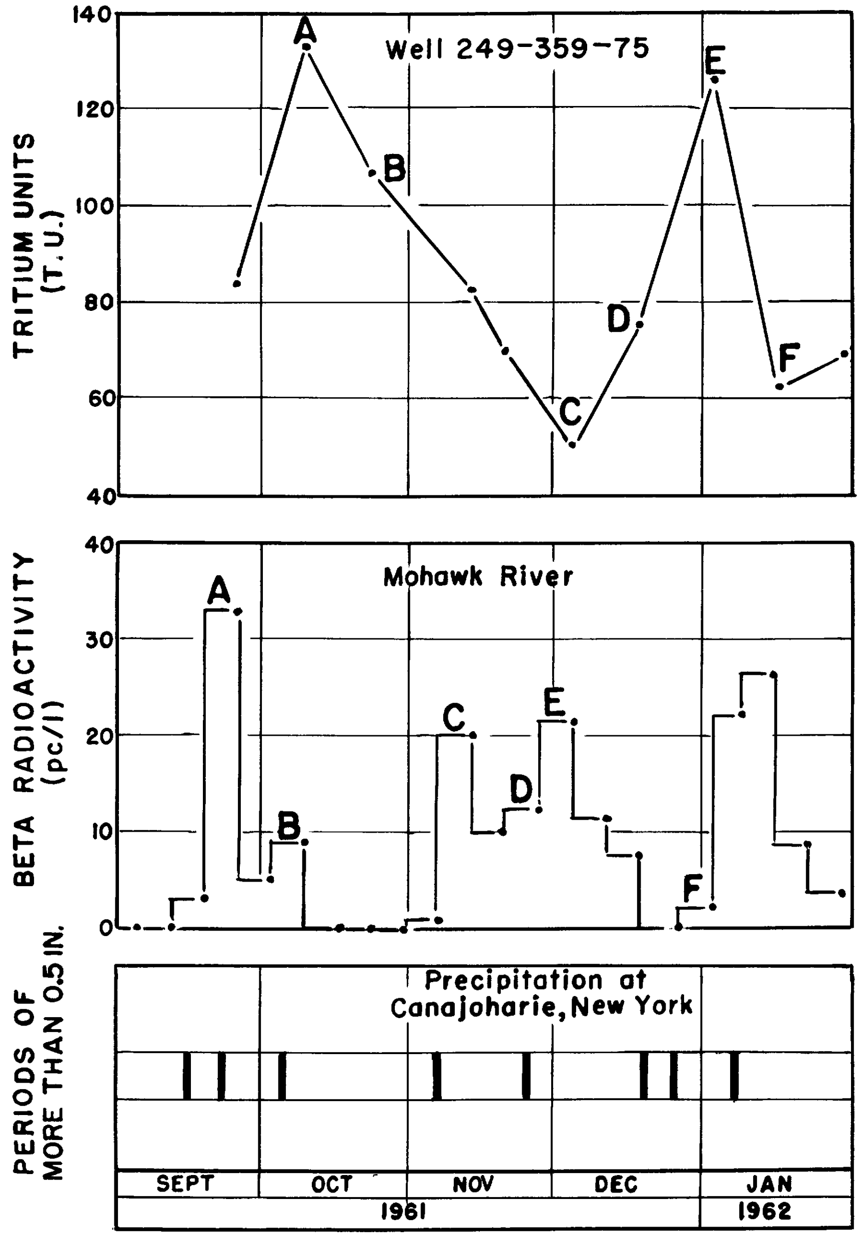


Figure 31.--Tritium content of water from well 249-359-75 and beta radioactivity of Mohawk River water, September 1961 to January 1962. (Tritium concentration is plotted on date sample was collected. Beta radioactivity is the average activity for a 7-day period and is plotted as of the last day of the period.)

time between collections of well samples. Both techniques provided useful data, but the date of peak levels cannot be conclusively established in either case.

The beta radioactivity peaks of river water occurred during or shortly after 1- to 3-day periods in which more than 0.5 inch of rain fell in a significant part of the Mohawk River drainage basin above Schenectady, as

shown in figure 31. The precipitation in the latter part of December 1961 fell as snow, but on January 6 and 7, 1962, the precipitation was in the form of rain when air temperatures were above freezing. Part of the radioactive material was brought down to the earth's surface with the rain and part was contained in snowmelt water. Water from these sources entered the river and caused the radioactivity peak in Mohawk River water at Schenectady in early January. Sampling of the well was not continued long enough to detect the arrival of this peak at the well field.

A more detailed study of the beta radioactivity of water from the Schenectady well field by the Knolls Atomic Power Laboratory in 1953 (M. R. Kennedy, written communication, 1962) indicated that water from the river moves to the well field with a significant reduction in the beta radioactivity. Figure 32 shows the beta radioactivity in rainfall in water from well 249-359-76 and in water from the Mohawk River between April 7 and June 30, 1953. The samples were collected at weekly intervals. Rain on April 27 had a beta radioactivity of 214,000 pc/l as a result of fallout from one of the thermonuclear test explosions in Nevada. The activity of river water on April 28 was 116 pc/l which reflects the activity in rain the day before. The relatively low beta activity in the river compared to that in the rain resulted from dilution of the rain in the river water, ion exchange with suspended sediment in the river, and the scattered distribution of rainfall. The beta radioactivity of water from well 249-359-76 was less than 17 pc/l, and did not show a marked increase until mid-June, about 48 days later. Most of the beta radioactivity measurements of water from the well did not exceed the background count of the counter. The beta radioactivity of water from the well was much less than that of the river because (1) radioactive substances were removed by ion exchange in the riverbed materials and in the aquifer in transit, (2) the rapid decrease of radioactivity with time as the water moved between the river and the well, and (3) an averaging of the activity of waters infiltrated from the river at different times (i.e., before, during, and after the peak on the river).

The U.S. Public Health Service, Drinking Water Standards (1962, p. 9 and 58-59) indicate that in the absence (or negligible presence) of Strontium-90 and certain alpha emitters, a water supply is acceptable when the gross beta radioactivity is less than 1,000 pc/l. The Standards also indicate that water supplies which contain a significant amount of Strontium-90 and the alpha emitters are very few. The highest beta activity found in well 249-359-76 during this investigation was 28 pc/l (fig. 32). The highest activity reported by Simpson and others (1959, tables 6 and 50, Schenectady well no. 2 is also well 249-359-76) from the same well during 1953-55 was only 40 pc/l. Thus, the radioactivity measured in the Schenectady well does not represent a hazard.

The principal safeguards against contamination by radioactive fallout appear to be the travel time of water between the river and the wells with attendant natural decay of radioactivity, ion exchange of radioactive substances in the riverbed materials and in the aquifer, and the mixing of water in the aquifer with less radioactive water. Because of these factors it is obvious that the water supply from the well fields is much safer with respect to radioactivity than if it were taken from the river.

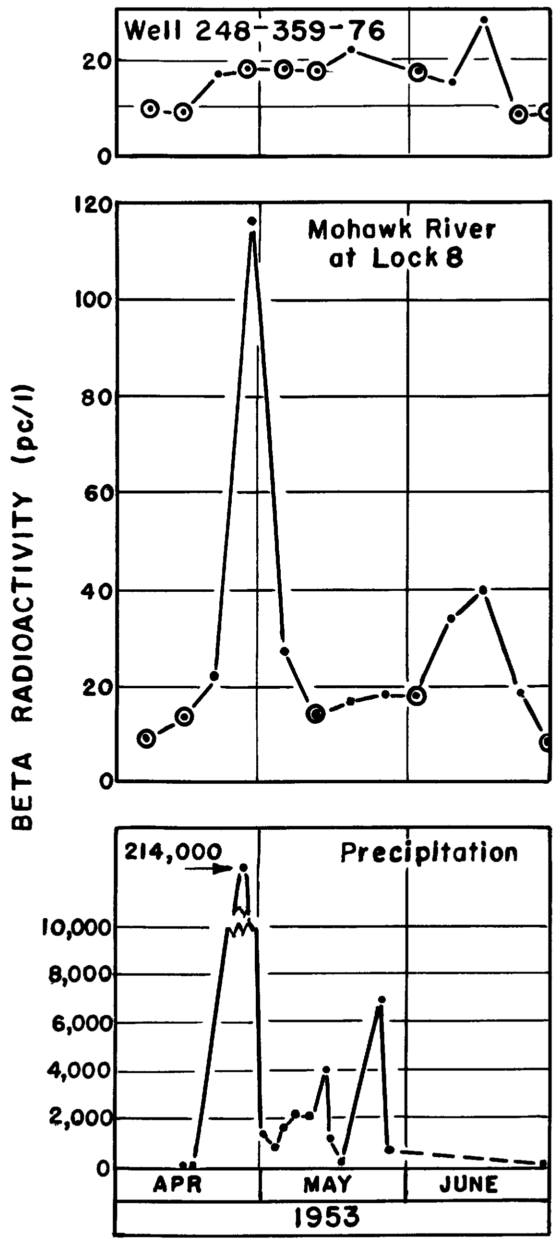


Figure 32.--Relationship between the beta radioactivity in rainfall, water from the Mohawk River, and water from well 249-359-76 in the spring 1953. Plotted points are circled where beta radioactivity of the sample did not exceed the counter background.

TRITIUM IN GROUND WATER NOT ASSOCIATED WITH STREAM INFILTRATION

Studies in New Jersey (Carlston and others, 1960, p. 509) have shown that ground water is chronologically layered in an aquifer recharged by precipitation, the youngest water being found at the water table. In their study the tritium content of water near the water table was found to be high (82 to 147 T. U.) and near the bottom of the aquifer (at a depth of about 100 feet) the tritium content was small (0 to 2 T. U.). It was

concluded that tritiated water from the 1954 (and later) thermonuclear tests had not reached below a depth of about 80 feet at the time of their study (1958).

During the present investigation two samples of water were also collected from well 248-359-73 for tritium analysis late in 1961. The well is cased in fine sand to a depth of 84 feet and is located more than 1,000 feet south of the Schenectady well field. (See plates 1 and 2.) The tritium content of water from the well was 98 T. U. on September 25, 1961, and 67 T. U. on December 4, 1961. The well is south of the Schenectady well field in an area in which ground-water movement, probably at only a few feet per day, is toward the well field. Recharge to the sand is from precipitation on the flood-plain surface and on the ridge to the west. Because of the depth below land surface at which the water from well 248-359-73 was obtained (84 feet or about 66 feet below the water table), it is believed that the water sampled on September 25, and December 4, 1961, entered the aquifer prior to September 1, 1961, and that the high tritium content of the water results from fallout from thermonuclear test explosions between 1952 and the beginning of the moratorium of nuclear testing in 1959.

Because of the relatively slow velocity of ground water in fine-grained deposits, such as those penetrated by well 248-359-73, water from wells in these deposits would probably be safe during periods of emergency resulting from large amounts of fallout, providing that the wells are protected from direct entrance of surface water. In addition, cased wells that obtain water from 20 feet or more below the water table would be safe for a longer period than a dug well that may obtain water at and just below the water table.

UTILIZATION OF WATER

All water used in eastern Schenectady County is from wells with the exception of cooling and process water pumped from the Mohawk River by the General Electric Company, and a small amount of water pumped from the same source for irrigation. Of the average 21 mgd pumped from wells in the area in 1961, nearly 18 mgd was pumped at the Schenectady and Rotterdam well fields. About 1 mgd was pumped by other public water supply systems. The yield of domestic and farm wells was about 1 mgd and the yield of industrial wells was less than 2 mgd.

DOMESTIC AND FARM SUPPLIES

In the areas not served by public water supply systems (fig. 2) water for home and farm use is obtained from individual wells. The approximate daily water use in these areas is about 1 mgd, based upon an approximate population of 16,000 and a per capita use of approximately 60 gpd per person. Inasmuch as agriculture constitutes a small part of the economy of the area, the use of water by stock and for irrigation is small.

PUBLIC WATER SUPPLY SYSTEMS

Most of the population of eastern Schenectady County is served by public water supply systems. The principal water supply systems are those of the city of Schenectady, the town of Rotterdam, the village of Scotia, and the village of Rotterdam Junction. Water obtained from the city of Schenectady serves most of the area of the town of Niskayuna. Smaller public water supply systems serve housing developments in the towns of Glenville and Rotterdam. A small public water supply system also serves the Glenridge Hospital and the Schenectady County Home. The average daily pumping rates for each of these water supply systems and the per capita water use is shown in table 8. The average per capita use of water is about 60 gpd if water use in Schenectady is excluded from the average. The higher per capita use of water in Schenectady (145 gpd) reflects, to some extent, industrial use.

The daily pumping rate will vary considerably above or below the daily average for the year. For example, in 1960 the maximum daily pumping rate from the Schenectady and Rotterdam well fields was 27.2 mgd and the minimum was 12.6 mgd--56 percent higher and 28 percent lower, respectively, than the daily average.

INDUSTRIAL WATER USE

Most of the water used by industries in eastern Schenectady County is obtained from municipal water supplies. The amount of water pumped from industry-owned wells is less than 2 mgd, of which the General Electric Company pumps about 0.9 mgd and the Schenectady Chemical Company pumps about 0.3 mgd. The General Electric Company also pumps between 70 and 140 mgd from the Mohawk River for process and cooling water, the amount varying with the temperature of the river water.

Table 8.--Pumpage and per capita use of water from public water supplies

Public water supply	Number of wells	Per capita water use (gallons)	Average daily pumping rate (1960-61) 1/ (gallons)
City of Schenectady	12	145	16,000,000
Town of Rotterdam	3	67	1,400,000
Village of Scotia	3	78	900,000
Village of Rotterdam Junction	2	78	86,000
Glenridge Hospital and Schenectady County Home	7	--	55,000
Forrest Hills - Mayfair Housing Development (Glenville Water District 5)	7	58	25,000
Willow Brook Park Housing Development (Glenville Water District 4)	2	46	23,000
West Hill Housing Development	4	69	17,000
Indian Hills Housing Development (Glenville Water District 9)	2	50	9,000
Woodhaven Housing Development (Glenville Water District 7)	4	45	8,000
		Total	18,523,000

1/ Year ending October 31, 1961.

DISPOSAL OF WATER

Nearly all of the water used in eastern Schenectady County is discharged either to the Mohawk River through sewage disposal plants or to the ground through septic tanks. Consumptive use of water is small, and is restricted principally to the watering of lawns and the small amount of irrigation that is done in the area. Consumptive use of water is water consumed in manufacturing processes, or water evaporated or transpired to the atmosphere as the result of human activity. It is water that is taken out of the local hydrologic system and, therefore, is not available for re-use in the area.

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GLOSSARY OF GROUND-WATER TERMS AND ABBREVIATIONS USED IN THE TEXT OF THIS REPORT

Term or abbreviation	Definition
Altitude	Distance, in feet, above mean sea level.
Aquifer	A formation, group of formations, or part of a formation that is water bearing.
cfs	Cubic feet per second.
Channel storage	The volume of water in definite stream channels above a given measuring point or "outlet" at a given time during the progress of runoff.
Cone of depression	The depression, roughly conical in shape, produced in a water table by pumping from a well.
Confining bed	One which, because of its position, and its impermeability or low permeability relative to that of the aquifer, prevents or retards the natural discharge of water from the aquifer into adjacent formations.
Drawdown	The vertical distance through which the water level in a well is lowered by pumping from the well at a given rate.
gpd	Gallons per day.
gpm	Gallons per minute.
Ground-water discharge	Discharge of water from the zone of saturation, usually to streams or other surface-water bodies, but may include the discharge from wells.
Ground-water recharge	Water that is added to the zone of saturation.
Ground-water runoff	That part of the runoff which has passed into the ground, has become ground water, and has been discharged into a stream channel as spring or seepage water.
Hydraulic gradient	Pressure gradient. As applied to an aquifer it is the rate of change of pressure head per unit of distance of flow at a given point and in a given direction.
Hydrograph	A graph showing level, flow, velocity, or other property of water with respect to time.
Infiltration	The flow or movement of water through the soil surface into the ground.
Infiltration capacity	The maximum rate at which the soil, when in a given condition, can absorb falling rain or melting snow.
mgd	Million gallons per day.
Permeability (P) (coefficient of)	The rate of flow of water in gallons a day (gpd) through a cross section of 1 square foot under a hydraulic gradient of 100 percent at a temperature of 60°F.
Permeability (P_F) (field coefficient of)	The rate of flow of water in gallons a day through a cross section of 1 square foot under a hydraulic gradient of 100 percent at the prevailing temperature of the ground water.
Porosity (p)	The ratio of the aggregate volume of pore spaces in a rock or soil to its total volume. It is usually stated as a percentage. (Porosity is equal to the sum of the specific yield and the specific retention.)
Runoff	The part of precipitation that appears in surface streams that are not regulated.
Safe yield	The rate at which water can be withdrawn from an aquifer without depleting the supply to such an extent that continued withdrawal at this rate is harmful to the aquifer itself, or to the quality of the water, or is not economically feasible. In practice, the safe yield is equal to or less than the mean annual recharge to the aquifer.
Screen loss (of a well)	That part of the drawdown in a pumping well that may be attributed to the restriction to free flow of water through the screen and the material immediately surrounding the screen.
Soil (zone)	A layer of loose earthy material, approximately parallel to the land surface, which has been so modified and acted upon by physical, chemical, and biological agents that it will support plant growth.
Specific capacity (of a well)	The ratio of the yield of a well to the drawdown of water level in the well at a given pumping rate; generally expressed in gallons per minute per foot of drawdown.
Static level (Hydrostatic level)	That level which, for a given point in an aquifer, passes through the top of a column of water that can be supported by the hydrostatic pressure of the water at that point. Corresponds to the water table or piezometric surface under static conditions.
Storage (S) (coefficient of)	The volume of water in cubic feet released from storage in each vertical column of an aquifer having a base 1 foot square when the water table or other piezometric surface declines 1 foot. (This is approximately equal to the specific yield for non-artesian aquifers.)
Stream infiltration	The flow or movement of water through the bed of a stream into the underlying material.
Transmissibility (T) (coefficient of)	The rate of flow of water in gallons per day through a section of aquifer 1 foot wide and having a height equal to the saturated thickness of the aquifer, under a hydraulic gradient of 100 percent, and at a temperature of 60°F. The coefficient of transmissibility is equal to the coefficient of permeability times the saturated thickness of the aquifer.
Water table	The upper surface of a zone of saturation.
Zone of aeration	The zone between the water table and the land surface in which the pore spaces of the rocks are not all filled (except temporarily) with water.
Zone of saturation	The zone in which the pore spaces of rocks are saturated with water under hydrostatic pressure.

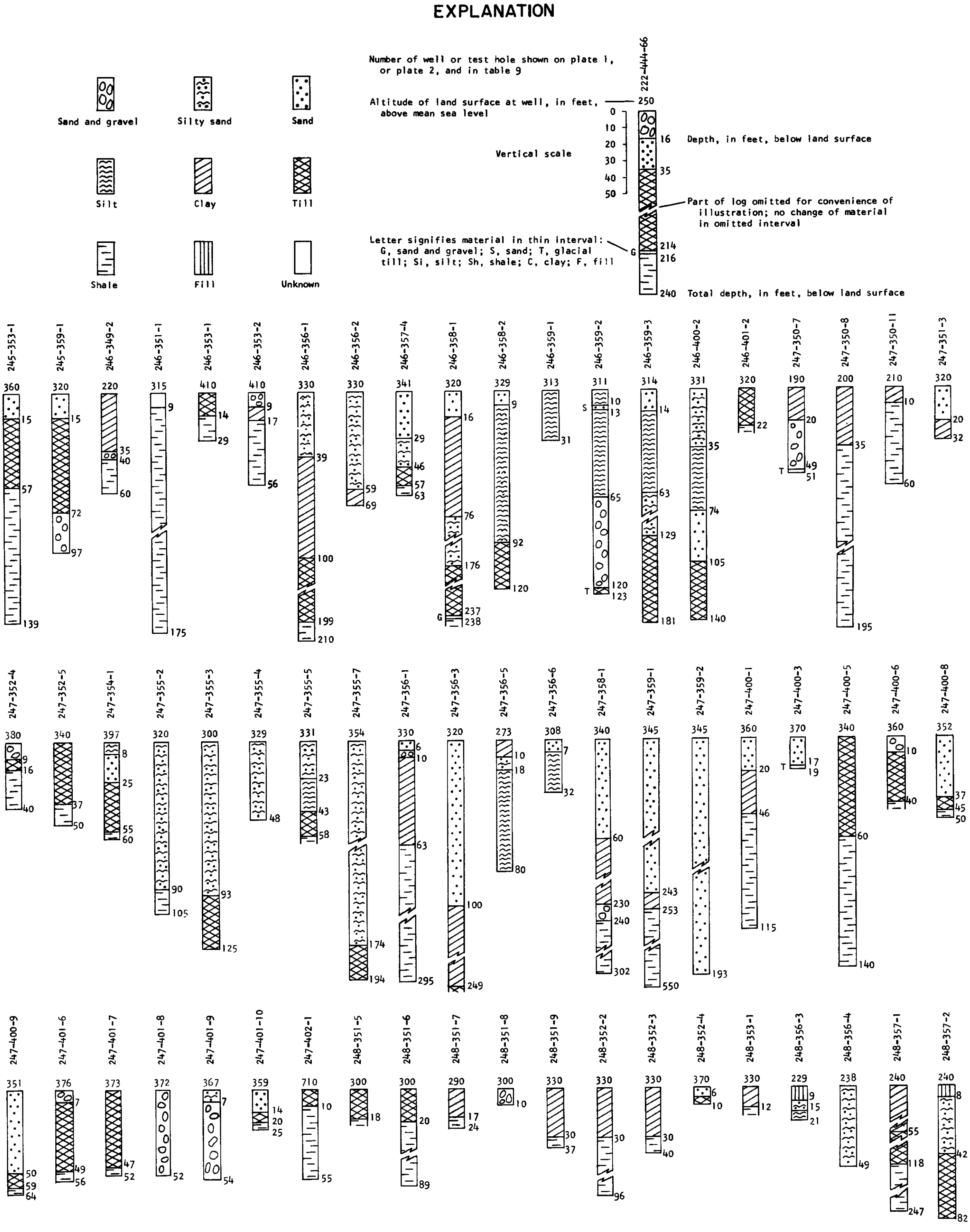

Figure 33.--Logs of selected wells and test holes in eastern Schenectady County.

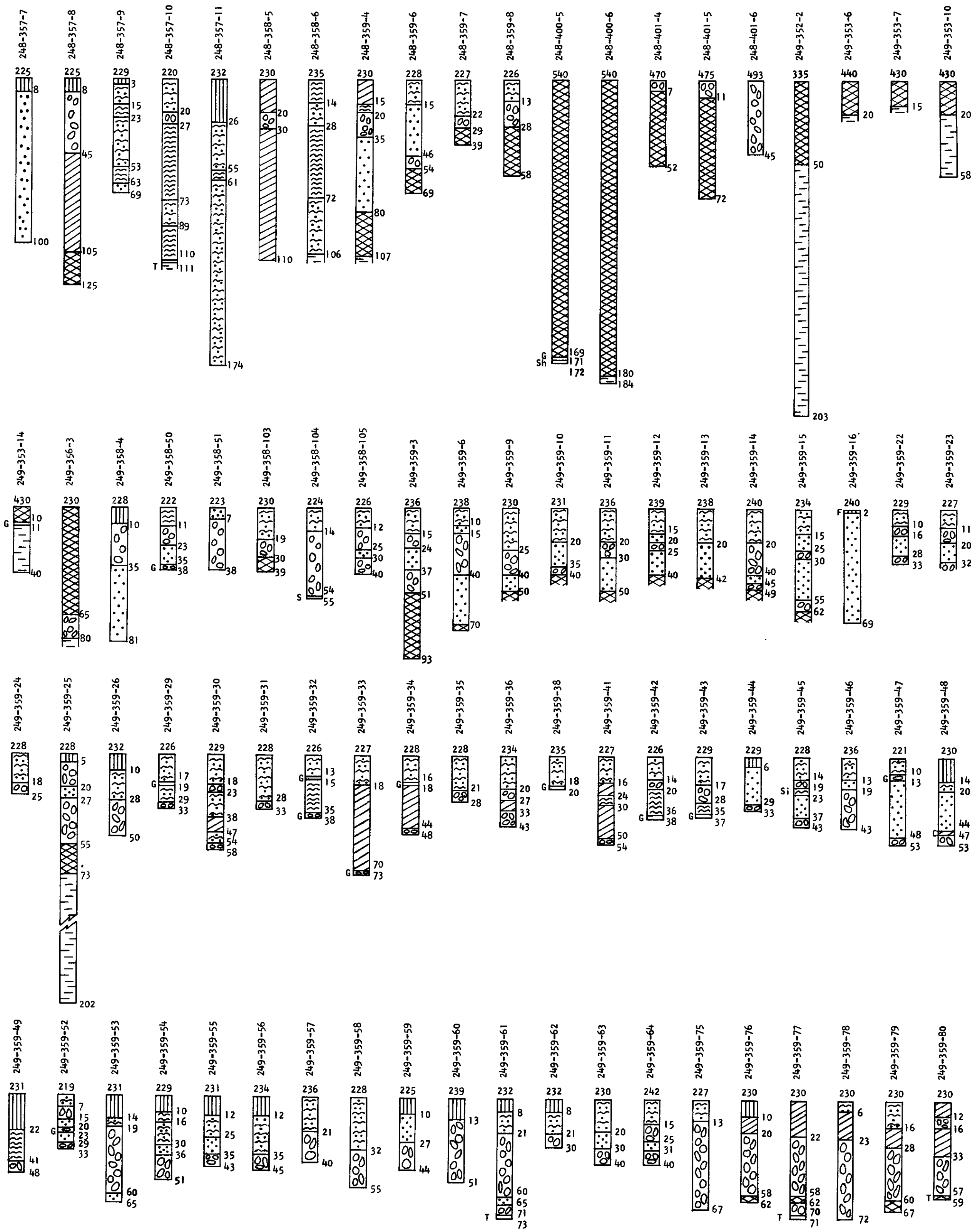

Figure 33.--Logs of selected wells and test holes in eastern Schenectady County (continued).

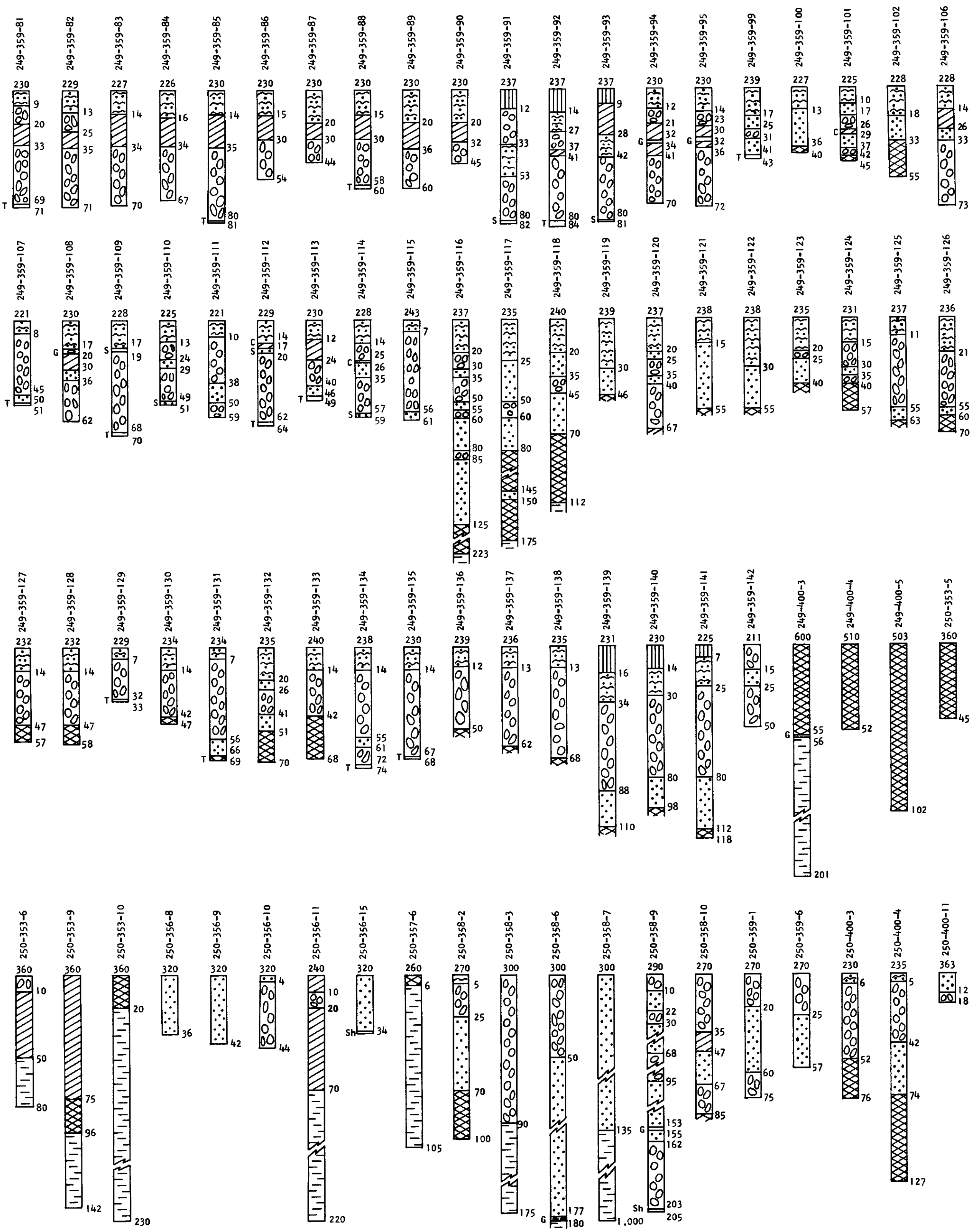

Figure 33.--Logs of selected wells and test holes in eastern Schenectady County (continued).

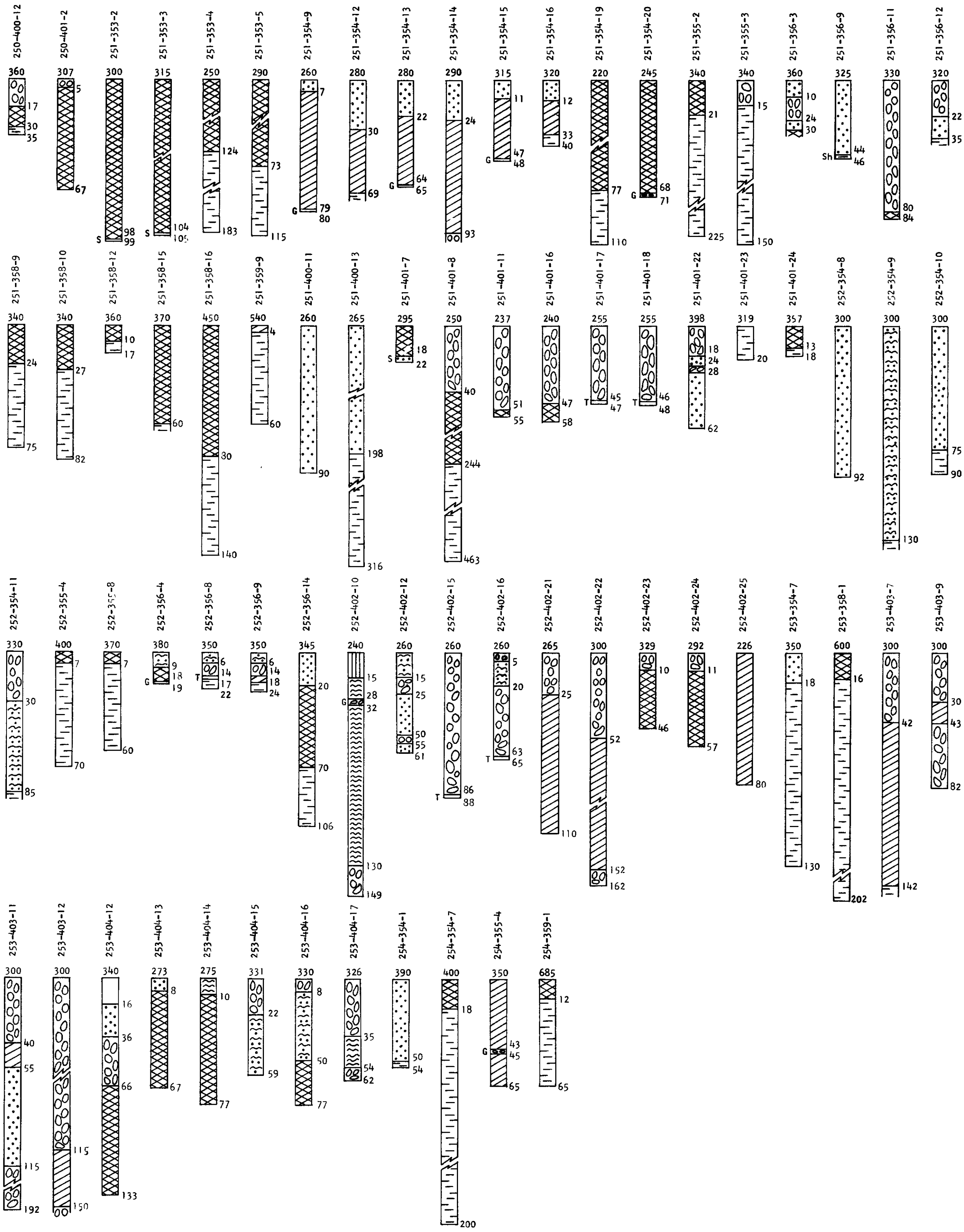

Figure 33.--Logs of selected wells and test holes in eastern Schenectady County (continued).

Table 9.--Records of selected wells and test holes in eastern Schenectady County

Well number: See "Well-Numbering System" in text for explanation.

Year completed:
a, about
b, before

Type of well:
Aug, augered
Drl, drilled
Dug
Dvn, driven
Jet, jetted
Dug-Dvn, where well was constructed by two methods of drilling, both methods of construction are shown.

Depth of well: All depths below land surface
a, about
s, less than
m, more than
r, reported depth--all other depths measured

Depth of casing: All depths below land surface
a, about
s, less than
In drilled and driven wells, depth of bottom of steel casing or depth to top of slots or screen where present.
In dug wells, depth of bottom of any casing (such as concrete tile or culvert pipe) that prevents infiltration of water except through bottom.
Depth omitted for stone curbed dug wells.

Diameter of well: Diameters of dug wells are approximate.
Where two or more sizes of casing are present in a drilled well, the top and bottom diameters are given.
Where well was constructed by two methods of drilling, the well of larger diameter is shown first.

Depth to bedrock: Below land surface
a, about
s, less than
m, more than
r, reported depth--all other depths measured
?, probable

Water-bearing material:
Cl, clay
Si, silt
S, sand
G, gravel
T, till
Ls, limestone or dolomite
Sh, shale
?, doubtful

Altitude above sea level: In feet above mean sea level
Altitude estimated from topographic maps.

Measuring point, description: Altitude, where shown, determined by instrumental leveling.

position: Distance given in feet and tenths of feet above land surface.
(-), distance below land surface
LS, at land surface

Water level, depth:
a, about
m, more than
r, reported level--all other levels measured
p, pumping level
(+), distance above land surface
F, additional water level measurements on file in Albany office of U. S. Geological Survey, Water Resources Division.
?, pumping effects probable

Use:
A, abandoned
C, commercial
D, domestic
De, destroyed
I, industrial
In, institutional
O, observation
PS, public supply
Ir, irrigation
S, stock
T, test
U, unused

Remarks:
y, measured yield in gallons per minute (gpm)
ry, reported yield
ey, estimated yield
ny, yield in normal use
dd, drawdown
ddsl, slight drawdown
h, hours pumped
adequate or inadequate, applies to yield for stated use as reported by owner
H_2S, well yields water containing hydrogen sulfide sufficient to cause objectionable taste or odor ("sulfur water")
A, chemical analysis given in this report
L, graphical log given in this report
T, temperature in degrees fahrenheit
F, additional temperature measurements on file in Albany office of U.S. Geological Survey, Water Resources Division
Sn , well number in Bulletin GW-30
S, screen length in feet
CS, City of Schenectady test well-year drilled-designation

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
245-353-1	S. Ruminski	1943	Drl	r139	57	6	57	Sh	360	--	--	r13	1943	D	ry 0.5,dd 126,h 0.5;L;Sn 176.
245-355-1	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r200	--	2	m200	S,Si	345	--	LS	r 0	1954	T	
245-359-1	Pine Grove School	--	Drl	r 97	97	6	m 97	G	320	--	--	--	--	In	ry 5;L; Sn 38.
-2	Baker	--	Drl	r250	250	6	m250	S	320	--	--	--	--	A	Inadequate;Sn 39.
246-349-1	J. L. Sutlaff	1928	Dvn	r 16	14	1¼	m 16	G	220	--	LS	r 3	1928	D	ry 8;S 2;Sn 150.
-2	A. E. Snelling	1924	Drl	r 60	40	6	40	Sh	220	--	LS	29.7	1947	D	ry 90;L;A;Sn 151.
246-351-1	M. Stark	1952	Drl	r175	9	6	9	Sh	315	Top of casing	LS	r 1	4/ /52	D	ry 3;L.
246-353-1	J. Connors	1947	Drl	29	14	8	14	Sh	410	--	LS	3	--	D	ry 4;L;Sn 313.
-2	Hodgkins	--	Drl	56	17	6	17	Sh	410	--	LS	3	--	D	ry 3.5;L;Sn 316.
246-355-1	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r196	--	2	m196	S,Si	356	--	LS	r 3	1954	T	
-2	do.	1954	Drl	r182	--	2	m182	S,Si	352	--	LS	r 3	1954	T	
246-356-1	P. Palazini	1946	Drl	r210	200	8	199	Sh	330	--	--	--	--	T	Inadequate;L;Sn 210.
-2	do.	1946	Drl	r 69	69	8	m 69	Cl	330	--	--	--	--	T	Inadequate;L; Sn 211.
246-357-1	Rotterdam School	1945	Dvn	r 15	15	6	m 15	S	325	Cellar floor	-3	r 7	8/ /45	In	ry 12;A;Sn 29.
-2	W. E. Sweeney	1941	Drl	r307	120	6	120	Sh	330	--	--	--	--	D	ry 0.75;A;Sn 30.
-3	Adams	--	Drl	r 74	30	6	30	Sh	345	--	--	--	--	D	ry 4;Sn 41.
-4	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 63	--	2	57	T,Sh	341	--	LS	r 6	1954	T	L.
246-358-1	---	--	Drl	r238	238	6	238	G	320	--	LS	r20	--	D	ry 4;L;Sn 40.
-2	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r120	--	2	m120	T	329	--	LS	r 4	1952	T	L.
246-359-1	do.	1952	Drl	r 31	--	2	m 31	Si	313	--	--	--	--	T	L.
-2	do.	1952	Drl	r123	--	2	m123	G	311	--	LS	r 3	1952	T	L.
-3	do.	1952	Drl	r181	--	2	m181	S,Si	314	--	LS	r 0	1952	T	L.
246-400-1	L. G. Derby	b1900	Dug	22	22	24	m 22	S	335	Top of cement rim	.4	17	4/28/47	D,S	Adequate;Sn 225.
-2	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r140	--	2	m140	S	331	--	LS	r 8	1952	T	L.
246-401-1	E. Crounse	a1900	Dug	14	--	48	m 14	T	370	Top of hand pump base	1.4	9.5	9/29/59	D	Marginally adequate.
-2	J. Feuz	a1800	Dug,Dvn	r 22	--	48,1¼	r 22	T	320	Top of wooden well cover	LS	15.1	9/30/59	D	Inadequate in summer;L.
-3	W. Just	--	Dug	25	--	36	m 25	T	370	Top of concrete well cover	.8	22	9/30/59	D	Marginally adequate.
247-350-1	R. Davis	--	Dug	8	--	18	m 8	T	240	Top of wooden frame on brick curbing	LS	3.2	8/ 4/59	U	
-2	A. Callahan	--	Dug	11	--	24	m 11	T	230	Top of iron grating	LS	5.8	8/ 4/59	A	
-3	M. Berger	1947	Drl	r 29	29	6	m 28	G	200	--	LS	4.1	1947	D,Ir	ry 4.
-4	I. Teagle	--	Dug	12	5	36	5	Sh	200	Top of concrete curbing	.8	11.3	8/ 4/59	D	Inadequate.
-5	do.	--	Drl	85	5	6	5	Sh	200	Top of casing	.4	9	8/ 4/59	D	Adequate yield;H_2S;A.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
247-350-6	Town of Niskayuna	1959	Dvn	46	46	2½	m 46	S,G	190	Top of casing	1.3	11.2	9/23/59	O	
-7	do.	1959	Drl	r 49	39	12	m 51	S,G	190	Top of casing	1	9.8	3/16/59	T	y 347,dd 6,h 120;S 10;L.
-8	H. V. Erben	1946	Drl	r195	35	8	35	Sh	200	--	LS	r10	11/ /46	A	Inadequate;L;Sn 214.
-9	do.	1946	Drl	r110	20	8	20	Sh	200	--	LS	r25	10/ /46	A	Inadequate;Sn 215.
-10	D. C. Woodin	1941	Drl	r 29	--	6	4	Sh	200	--	LS	0	--	D	ry 10;Sn 290.
-11	G. Parker	--	Dug	60	--	48	10	Sh	210	--	LS	20	--	D	L;Sn 291.
-12	J. Wettergreen	1946	Drl	27	--	6	m 27	G	240	--	LS	15	--	D	ry 30;Sn 292.
-13	C. W. Lewis, Jr.	--	Drl	50	--	6	12	Sh	240	--	--	12	--	D	Sn 293.
247-351-1	R. Baldwin	1935	Dug	10	10	24	m 10	S	310	Top of tile	.5	6.2	8/ 4/59	D	Adequate;A.
-2	C. W. Frye	--	Dvn	32	30	1¼	m 32	S,Cl	320	--	LS	24 ?	--	D	S 2;Sn 294.
-3	T. Shortsleeves	--	Dug	32	--	48	m 32	Cl	320	--	LS	25 ?	--	D	L; Sn 295.
-4	F. Wirth	1945	Drl	295	96	8	96	Sh	320	--	--	--	--	A	Inadequate;Sn 296.
-5	L. Brinkman	1936	Drl	72	72	8	m 72	S	320	--	LS	20	--	D	Inadequate;Sn 297.
247-352-1	R. MacNab	--	Dug	18	18	24	m 18	S	330	--	LS	9.2	6/ 8/48	D	Adequate;Sn 298.
-2	H. L. Weinberg	--	Dug	16	--	48	m 16	S	340	--	LS	7.5	6/ 7/48	D	Adequate;Sn 308.
-3	J. Pollak	--	Dug	26	26	48	m 26	T	340	--	LS	15	--	D	Adequate;Sn 311.
-4	S. Salamore	1947	Drl	40	16	8	16	Sh	380	--	LS	10	--	D	ry 0.75;L;Sn 312.
-5	W. J. Enright	1916	Drl	50	37	6	37	Sh	340	--	--	--	--	D	ry 2;L;H_2S;Sn 317.
-6	C. Pohl	1937	Dvn	41	41	8	m 41	G	390	--	LS	r13	1937	D	ry 6,dd 17;T 50;Sn 175.
247-354-1	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r 60	--	2	55	T,Sh	397	--	LS	r13	1954	T	L.
247-355-1	Connelly Bros. Dairy	1936	Drl	r 30	30	8	m 30	G	350	--	LS	r14	8/ /45	D	ry 3;Sn 52.
-2	N.Y.S. Dept. of Pub. Wks.	1949	Drl	r105	--	2	90	S,Si	320	--	--	--	--	T	L;Sn 335.
-3	do.	--	Drl	r125	--	2	m125	S,Si	300	--	--	--	--	T	L;Sn 336.
-4	do.	1954	Drl	r 48	--	2	m 48	S,Si	329	--	LS	r24	1954	T	L.
-5	do.	1954	Drl	r 58	--	2	58	Sh	331	--	--	--	--	T	L.
-6	do.	1954	Drl	r120	--	2	m120	S,Si	347	--	LS	r15	1954	T	
-7	do.	1954	Drl	r194	--	2	m194	T	354	--	LS	r 5	1954	T	L.
247-356-1	M. Kverek	1945	Drl	r295	63	6	63	Sh	330	--	LS	r120 ?	9/ 6/45	D	L;H_2S;Sn 32.
-2	Polar Ice Co.	a1938	Drl	r 45	45	8	m 45	S	320	--	LS	r 8	3/ /45	I	ry 45,dd 34,h 12;ny 40;Sn 208.
-3	do.	1945	Drl	r249	249	8	m249	--	320	--	--	--	--	A	L;Sn 209. Well not completed.
-4	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r 37	--	2	--	S	291	--	LS	r 5	1954	T	
-5	do.	1954	Drl	r 80	--	2	m 80	S,Si	273	--	LS	r 4	1954	T	L.
-6	do.	1954	Drl	r 32	--	2	m 32	Si	308	--	LS	r16	1954	T	L.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
247-357-1	G. Farr	1930	Drl	r421	220	6	220	Sh	320	--	LS	r45	--	D	ry 7;T 50;Sn 31.
247-358-1	P. J. Schwarzhaupt	1944	Drl	r302	240	6	240	Sh	340	--	LS	r72	8/ /44	D	ry 60;L;A;T 50±;Sn 27.
-2	do.	1944	Dvn	r 40	38	1¼	m 40	S	340	--	LS	r25	5/ /44	D	ey 2;S 2;A;Sn 28.
247-359-1	Schenectady School Dist.-11	1933	Drl	r550	253	6	253	Sh	345	--	--	--	--	A	Inadequate;L;Sn 35.
-2	---	--	Drl	r193	193	6	m193	S	345	--	--	--	--	-	ry 3;L;Sn 36.
247-400-1	C. Van Valkenburg	1949	Drl	r115	46	6	46	Sh	360	--	LS	r14	1949	D	ry 3;L;H_2S.
-2	General Electric Co.	1929	Dug	r 16	16	36	5	Sh	360	Top of tile	-5.7	9.4	9/21/59	A	H_2S.
-3	C. Van Valkenburg	--	Dug	r 19	--	36	m 19	S	370	Cellar floor	-6	r14	7/28/45	D	Adequate;L;Sn 61.
-4	---	--	Drl	r148	89	6	89	Sh	370	--	LS	0	--	D	Flowing y 1;Sn 63.
-5	---	--	Drl	r140	60	6	60	Sh	340	--	--	--	--	A	Inadequate;L;Sn 64.
-6	Radio station WGY	--	Drl	r 40+	40	8	40	Sh	360	--	--	--	--	U	y 0.5;L;reported salty;Sn 65.
-7	D. Cuomo	1943	Drl	r 55	55	8	m 55	S,G	340	--	LS	r13	1943	D	y 9;dd 37,h 0.25;Sn 169.
-8	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 50	--	2	45	T,Sh	352	--	LS	r22	1952	T	L.
-9	do.	1952	Drl	r 64	--	2	59	Sh	351	--	LS	r50	1952	T	L.
247-401-1	C. Van Vuren	1959	Dug	16	--	--	m 16	T	400	Cellar floor	-4	16	9/18/59	D	Inadequate.
-2	R. Weisheit	1954	Dug	14	14	36	m 14	T	410	Top of concrete tile	2	13.1	9/18/59	D	Do.
-3	J. Mastrianni	1950	Drl	r 62	4	6	4	Sh	370	--	LS	r 7	--	D	Adequate;H_2S.
-4	F. Santore	--	Dug	20	6	30	6	Sh	480	Top of marble well cover	3	8.5	9/30/59	A	
-6	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 56	--	2	49	Sh	376	--	LS	r 4	1952	T	L.
-7	do.	1952	Drl	r 52	--	2	47	Sh	373	--	LS	r 9	1952	T	L.
-8	do.	1952	Drl	r 52	--	2	m 52	G	372	--	LS	r10	1952	T	L.
-9	do.	1952	Drl	r 54	--	2	m 54	G	367	--	LS	r14	1952	T	L.
-10	do.	1952	Drl	r 25	--	2	20	T,Sh	359	--	LS	r 1	1952	T	L.
247-402-1	F. Loaman	1937	Drl	r 55	10	6	10	Sh	710	--	LS	r19	1937	D	y 2,dd 31,h 0.25;L;Sn 172.
248-351-2	A. Streeben	1953	Drl	r130	40	6	40	Sh	300	--	LS	17	1953	D	Adequate;H_2S;A.
-3	J. Warner	1943	Dug	19	19	24	m 19	T or S,Si	300	Top of glazed tile casing	1.5	15.9	8/ 4/59	D	Inadequate in late summer;A.
-4	F. Scheckelman	--	Dug	30	--	48	30	Sh	310	--	--	--	--	D	Sn 281.
-5	M. Cummings	--	Dug	18	18	26	18	Sh	300	--	LS	2	--	D	L;Sn 285.
-6	C. Whitmyer	a1900	Drl	89	20	6	20	Sh	300	--	LS	20	--	D	L;T 54;Sn 286.
-7	do.	--	Dug	24	17	36	17	Sh	290	--	LS	4	--	D	L;Sn 287.
-8	R. Baldwin	--	Dug	r 10	10	24	m 10	G	300	--	LS	4	6/ 2/48	D	Adequate;L;Sn 289.
-9	F. Wagner	a1900	Drl	r 37	30	6	30	Sh	330	--	LS	r20	--	D,S	ry 3.5;L;Sn 283.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
248-352-1	J. Prazak	1931	Dug	14	14	24	m 14	T	330	Top of recess in glazed tile	-1.8	10.9	7/31/59	D	Inadequate;H_2S,A.
-2	L. Weston	1938	Drl	r 96	30	8	30	Sh	330	--	--	r20	1938	D,S	ry 5;L;A;Sn 282.
-3	F. Schopmeier	a1900	Drl	40	30	6	30	Sh	330	--	LS	r15	--	D,S	ry 3;L;A;T 51;Sn 284.
-4	C. Steinhauer	--	Dug	10	--	36	m 10	T	370	--	LS	r 7	--	D	L;Sn 325.
248-353-1	V. Polsinelli	--	Dug	r 12	--	48	12	Sh	330	--	LS	r 6	--	S	L;Sn 275.
-2	R. W. Jacob	1939	Drl	r185	14	8	14	Sh	450	--	LS	r18	--	D	ry 0.5;slight H_2S;Sn 276.
248-356-1	General Ice Cream Co.	1932	Drl	r504	70	12	70	Sh	280	--	LS	r74 ?	--	A	ry 100(short periods),dd 146,h 48, inadequate;slight H_2S;Sn 53.
-2	Col-Ice Co.	1939	Drl	r 59	48	10	m 59	S,G	240	--	LS	r12	1939	I	ry 300;S 11;Sn 37.
-3	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r 21	--	2	m 21	S,Si	229	--	LS	r 8	1954	T	L.
-4	do.	1954	Drl	r 49	--	2	m 49	S,Si	238	--	LS	r 9	1954	T	L.
248-357-1	Mica Insulator Co.	1937	Drl	r247	118	6	118	Sh	240	--	--	--	--	De	Inadequate;L;Sn 33.
-2	do.	1937	Drl	r 82	82	6	m 82	T	240	--	--	--	--	De	Inadequate;L;Sn 34.
-7	General Electric Co.	--	Aug,Drl	r100	--	2	m100	S	225	--	--	--	--	T	L.
-8	do.	a1953	Drl	r125	125	6	m125	--	225	--	--	--	--	A	ry 150, from sand and gravel at 45 ft;L.
-9	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r 69	--	2	m 69	S	229	--	LS	r11	1954	T	L.
-10	do.	1954	Drl	r111	--	2	111	--	220	--	LS	r 9	1954	T	L.
-11	do.	1954	Drl	r174	--	2	m174	S,Si	232	--	LS	r19	1954	T	L.
248-358-1	Q. Lomini	1954	Dug	14	14	30	m 14	S,G	230	Top of concrete tile	LS	11.6	9/ 1/59	Ir	Inadequate in late summer;A.
-2	do.	--	Dug	13	--	--	m 13	S,G	230	--	LS	10.5	9/ 1/59	Ir	ry 4.
-3	Shell Service Station	1959	Drl	r 95	95	6	m 95	S	230	--	--	--	--	C	ry 25.
-4	General Electric Co.	1953	Drl	100	85	10-8	100	G	230	--	--	12	--	I	y 350;S 15;T 55;Sn 343.
-5	Town of Rotterdam	1948	Drl	r110	110	8	m110	Cl	230	--	--	r15	--	T	L;Sn 323.
-6	N.Y.S. Dept. of Pub. Wks.	1954	Drl	r106	--	2	106	S,Si	235	--	LS	a22	1954	T	L.
-7	General Electric Co.	--	Drl	r 40	--	6	m 40	S,G	225	--	--	--	--	A,I	ry 200;Sn 45.
248-359-1	E. Ahl	1942	Dug	14	--	48	m 14	S	290	Top of 3-inch air pipe in well cover	LS	12	10/16/59	D	Usually adequate;A.
-2	J. Flowers	--	Dug	16	16	36	m 16	S	290	Top of 2-inch pipe	2.3	10.9	10/16/59	Ir	
-4	Town of Rotterdam	1948	Drl	r107	107	8	107	Sh	230	--	--	20	1/ /48	A,T	L;Sn 322.
-5	S. Schermerhorn	1923	Drl	r 53	53	6	m 53	S,G	300	--	--	r17	1923	D	y 4,dd 25;T 50;Sn 171.
-6	City of Schenectady	1931	Drl	r 69	--	6	m 69	G	228	--	--	--	--	T,De	L;CS-1931-D.
-7	do.	1931	Drl	r 39	--	6	m 39	G	227	--	--	--	--	T,De	L;CS-1931-E.
-8	do.	1931	Drl	r 58	--	6	m 58	G	226	--	--	--	--	T,De	L;Cs-1931-F.
-9	L. & M. Motel	1960	Drl	r 84	84	6	m 84	S	230	Top of casing	-6	F17.4	9/25/61	C	y 15;A;T 53.
248-400-1	K. Moyer	1957	Drl	r105	10	6	10	Sh	360	Top of air pipe	2	37	9/16/59	D	Adequate;H_2S;A.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
248-400-2	G. Robison	b1900	Dug	27	--	36	--	Sh	380	Top of pump housing with cover removed	3.8	10.1	9/16/59	D	Inadequate;A.
-3	A. Matula	b1900	Dug	14	--	36	m 14	T	450	Top of brick curbing	1.4	10.8	9/18/59	D	Inadequate;A.
-4	West Hill Water Co.	1948	Drl	r100	97	6	100	S,G	540	--	LS	r40	1948	PS,A	ry 27;A.
-5	do.	1960	Drl	r172	170	6	171	Sh	540	--	LS	r75	9/ /60	PS	ry 25,dd 3,h 6;L;A.
-6	do.	1960	Drl	r184	180	6	180	Sh	540	--	LS	r96	9/ 8/60	PS	ry 17,dd 23;L;A.
248-401-1	J. Kwiatkowski	1954	Drl	98	75	6	75	Sh	450	Top of casing	LS	19.8	9/18/59	D	Adequate;A.
-3	N. Cuomo	1946	Drl	r240	142	8	142	Sh	450	--	LS	Flowing	--	I	ry 3.5,dd 220,h 0.5;Sn 168.
-4	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 52	--	2	m 52	T	470	--	LS	r12	1952	T	L.
-5	do.	1952	Drl	r 72	--	2	m 72	T	475	--	LS	r 0	1952	T	L.
-6	do.	1952	Drl	r 45	--	2	m 45	G	493	--	LS	r 3	1952	T	L.
248-402-1	J. English	1937	Drl	65	--	6	0	Sh	910	--	--	--	--	D,S	y 7;A;H_2S;Sn 119.
249-352-1	C. Steinhauer	1944	Dug	10	10	36	m 10	T	350	Top of tile casing	LS	7.2	7/31/59	D	Adequate.
-2	H. Ottoway	--	Drl	203	50	6	50	Sh	335	--	--	--	--	A	Inadequate;L;Sn 279.
-3	R. W. Shugg	--	Dug	26	--	36	s 26	T,Sh	320	--	LS	15	--	D	Sn 331.
-4	H. Yager	--	Dug	14	14	36	m 14	T	330	--	--	--	--	D	Sn 332.
-5	W. F. Yager	--	Dug	11	11	48	m 11	T	320	--	LS	4.3	--	D	Sn 333.
-6	F. C. Ewing	--	Dug	16	--	36	16	Sh	390	--	--	--	--	U	Sn 271.
249-353-1	G. Welch	b1900	Dug	13	--	24	m 13	T	400	Recess in concrete for wooden cover	LS	11.2	7/30/59	D	Inadequate.
-2	do.	--	Dug	15	--	36	m 15	T	400	Top of 1½-inch air pipe	1	8.3	7/30/59	D	Usually adequate;A.
-3	F. Legere	--	Dug	15	15	24	m 15	T	430	Recess near top of 24-inch tile	-3	13.2	7/30/59	D	Adequate.
-4	J. Shopmyer	1957	Dug	14	8	36	8	Sh	420	Top of 36-inch concrete tile	1	11.3	7/31/59	D	Inadequate.
-5	F. Greismer	--	Dug	r 12	--	48	6	Sh	415	--	--	--	--	D	Inadequate;Sn 264.
-6	E. J. Quackenbush	--	Dug	r 20	--	48	20	Sh	440	--	LS	15	--	D	L;Sn 265.
-7	A. Rejack	--	Dug	r 15	--	48	15	Sh	430	--	--	--	--	D	L;Sn 268.
-8	W. Rejack	--	Dug	r 12	12	36	12	Sh	400	--	LS	8	--	D	Sn 269.
-9	J. Greismer	--	Drl	r100	30	6	30	Sh	400	--	--	--	--	D	Sn 270.
-10	E. Delzetto	1948	Drl	r 58	20	8	20	Sh	430	--	LS	r20	--	D	ry 1;L;Sn 320.
-11	C. Finkle	--	Dug	r 12	--	10-8	0	Sh	350	--	--	--	--	D,C	Adequate;Sn 330.
-12	J. Leuschner	--	Dug	18	--	48	m 18	T	370	--	LS	6.5	--	D	Adequate;Sn 326.
-13	E. Heck	--	Dug	14	14	48	m 14	T	360	--	LS	11	--	D	Adequate;Sn 327.
-14	E. Delzetto	1948	Drl	40	11	6	11	G,Sh	430	--	--	--	--	D	ry 0.5;L;Sn 321.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
249-355-1	G. Murray	--	Dug	--	--	60	--	T	220	Top of opening in brick well cover	-0.5	3.8	7/16/59	A	
249-356-1	B. Spurglasz	1959	Drv	31	28	1¼	m 31	S	250	Top of casing	.4	22.1	7/15/59	U	S 3.
-3	Pine Grove Dairy	1937	Drl	r 80	80	6	80	G	230	--	--	--	--	I	ry 60;L;Sn 22.
249-358-1	P. Ulrich	b1900	Dug	32	--	48	m 32	S,G	220	Top of stone curbing	LS	29.1	7/28/59	D,C	Adequate;A.
-2	L. Hyde	--	Drv	26	23	1¼	m 26	S	225	Top of 1¼-inch pipe with elbow removed	-2.4	20.4	7/28/59	C	Adequate;S 3.
-3	M. Lilliquist	--	Dug,Drv	r24,--	24	36-1¼	m 24	G	220	Top of concrete tile	-1.5	23.6	7/28/59	U	
-4	Town of Glenville	1961	Drl	81	68	6	m 81	S	228	Top of casing	LS	F16.8	3/ 1/61	O	L.
-5	N. Rohats	--	Drl	34	34	6	m 36	S	241	Top of casing(Alt. 234.2)	-7	27.3	6/ 1/61	A	
-6	do.	1961	Drl	48	48	6	m 48	S	241	Top of casing	-7	27.5	3/ 7/61	D	ry 3.
-50	H. Payne	1960	Aug,Jet	36	34	1¼	m 38	G	222	Top of casing(Alt. 224.88)	3	F 8.5	5/19/60	O	S 2;L;T 52.9,F.
-51	do.	1960	Aug,Jet	28	28	1¼	m 38	S,G	223	Top of casing(Alt. 225.65)	3	F13.4	5/19/60	O	L;T 52.0;F.
-67	N.Y.S. Dept. of Pub. Wks.	1960	Jet	13	13	1¼	m 13	S,G	220	Top of casing(Alt. 222.50)	2.5	F11.2	7/13/60	O	y 5,dd 2,h 0.5;T 69.5;F.
-71	do.	1960	Jet	7	7	1¼	m 7	S,G	215	Top of casing(Alt. 218.03)	3	F 5.7	11/16/60	O,De	Destroyed 2/26/61 by ice jam.
249-358-103	City of Schenectady	1931	Drl	r 39	--	6	m 39	S,G	230	--	--	--	--	T,De	L;CS-1931-H.
-104	do.	1931	Drl	r 55	--	6	m 55	S,G	224	--	--	--	--	T,De	L;CS-1931-J.
-105	do.	1931	Drl	r 40	--	6	m 40	G	226	--	--	--	--	T,De	L;CS-1931-K.
249-359-1	E. Buhrmaster	b1940	Dug	38	--	44	m 38	G	240	Top of wooden well cover	.5	14.3	6/23/59	D	Adequate.
-2	B., W., and E. McMichael	b1900	Dug	35	--	48	m 35	S	250	Bottom of concrete curbing	LS	30	7/28/59	D,S	Adequate;A;Sn 26.
-3	City of Schenectady	1954	Drl	93	93	6	m 93	--	236	Top of casing(Alt. 235.90)	--	--	--	T	L;well plugged.
-4	N.Y.S. Dept. of Pub. Wks.	--	Drl	158	--	6	--	Sh	230	Top of metal cover on casing	.4	4	8/10/59	De	H_2S;T 75.5;F;destroyed 1961.
-5	City of Schenectady	1918	Drl	67	67	6	m 67	S,G	240	Top of casing	.6	30.7	8/11/59	T,A	
-6	do.	1927	Drl	38	38	6	m 70	S,G	238	Top of casing(Alt. 237.85)	4	F28.7	8/18/59	T,O	L;T 61.1;F;CS-1927-5.
-8	do.	--	Drl	32	32	6	m 32	S,G	230	Top of casing(Alt. 234.24)	3.7	F24.6	8/19/59	O	T 52.3;F;Sn 216.
-9	do.	1927	Drl	31	31	6	m 50	S,G	230	Top of casing(Alt. 235.13)	5	F22.4	8/25/59	O	L;T 48.3;F;CS-1927-14.
-10	do.	1927	Drl	25	25	6	m 40	S	231	Top of casing	2	20.2	8/24/59	T	L;CS-1927-15.
-11	do.	1927	Drl	38	38	6	m 50	S	236	Top of casing(Alt. 236.34)	.7	28.3	8/25/59	O	L;CS-1927-13.
-12	do.	1927	Drl	38	38	6	m 40	S	239	Top of casing	LS	29.7	8/25/59	T	L;well partially plugged;CS-1927-8.
-13	do.	1927	Drl	36	36	6	m 42	S	238	Top of casing(Alt. 238.40)	.5	F31.9	8/25/59	T,O	L;T 65.2;F;CS-1927-12.
-14	do.	1927	Drl	32	32	6	m 49	S,G	240	Top of casing	-.3	31.3	8/25/59	T	L;well partially plugged;CS-1927-9.
-15	do.	1927	Drl	35	35	6	m 62	S	234	Top of casing(Alt. 234.49)	.4	F25.5	8/26/59	T,O	L;T 56.4;F;CS-1927-17.
-16	L. & M. Motel	1957	Drl	69	--	8	m 69	S	240	Top of cover on casing	-5.6	19.6	9/ 1/59	C	ry 40,dd 8,h 1;L;A.
-17	T. Martin	1952	Drl	55	--	6	--	Sh	410	Top of casing	-4	P45	9/16/59	D	Inadequate in late summer;H_2S,A.
-18	J. Marlette	--	Drv	--	--	--	--	S	270	--	LS	Flowing	--	U	y 0.1;A;T 59.5;developed spring.
-19	A. Lavallee	--	Dug	--	--	--	--	S	350	--	LS	3.5	--	U	y 0.2;A;T 56.5.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
249-359-20	City of Schenectady	1959	Dvn	45	43	1¼	m 45	S	232	Top of 1¼-inch pipe (Alt. 231.75)	LS	F22.1	10/26/59	O	S 2;T 49.3;F.
-21	do.	1959	Dvn	42	40	1¼	m 42	S	226	Top of 1¼-inch pipe (Alt. 226.19)	LS	F14.3	10/26/59	O	S 2;T 49;F.
-22	do.	1959	Jet	33	33	1¼	m 33	S,G	229	Top of casing(Alt. 230.41)	1.5	F15.4	10/21/59	O	L;T 54.6;F.
-23	do.	1959	Jet	32	32	1¼	m 32	S,G	227	Top of casing(Alt. 230.24)	3	F14.4	10/22/59	O	L;T 54.4;F.
-24	do.	1959	Jet	25	25	1¼	m 25	S,G	228	Top of casing(Alt. 231.15)	3	F18.5	10/26/59	O	L;T 56.8;F.
-25	N.Y.S. Dept. of Pub. Wks.	1959	Drl	202	73	6	73	Sh	228	Top of casing(Alt. 230.12)	2.5	0	3/10/60	D	y 5,dd 173,h 24;L;T 50;H_2S,A.
-25	do.	1959	Drl	202	73	6	73	S,G	228	Top of casing(Alt. 230.12)	2.5	15.1	6/27/60	D	y 40,dd 0.4,h 2;T 61.4;F;casing blasted at 50 ft.
-26	do.	1960	Drl	50	47	6	m 50	S,G	232	Top of casing(Alt. 234.46)	2.5	F23.3	3/ 2/60	O	y 40;S 3 (2 inch diameter);L;A;T 44.0;F.
-29	City of Schenectady	1960	Aug,Jet	33	33	1¼	m 33	G	226	Top of casing(Alt. 229.32)	3.6	F17.9	5/ 3/60	O	L;T 48.1;F.
-30	do.	1960	Aug,Jet	58	58	1¼	m 58	G	229	Top of casing(Alt. 234.01)	5.3	F21.5	5/ 4/60	O	L;T 48.3;F.
-31	do.	1960	Aug,Jet	32	32	1¼	m 33	G	228	Top of casing(Alt. 229.96)	2	F13.9	5/ 4/60	O	L;T 47.8;F.
-32	do.	1960	Aug,Jet	38	38	1¼	m 38	G	226	Top of casing(Alt. 229.34)	3.5	F13.5	5/ 4/60	O	L;T 49.2;F.
-33	do.	1960	Aug,Jet	63	63	1¼	m 73	S,G	227	Top of casing(Alt. 227.24)	LS	F18.7	5/ 9/60	O	L;A;T 49.3;F.
-34	do.	1960	Aug,Jet	47	45	1¼	m 48	G	228	Top of casing(Alt. 229.42)	1.7	F14.8	5/ 9/60	O	S 2;L;T 49.3;F.
-35	do.	1960	Aug,Jet	23	23	1¼	m 28	G	228	Top of casing(Alt. 230.58)	3.1	F20.6	5/ 5/60	O	L;T 55.9;F.
-36	do.	1960	Aug,Jet	33	33	1¼	m 43	G	234	Top of casing(Alt. 237.24)	3.4	F26.6	5/ 6/60	O	y 20;L;A;T 58.1;F.
-38	do.	1960	Aug	19	17	1¼	m 20	G	235	Top of casing(Alt. 236.95)	2	Dry	5/12/60	T	S 2;L.
-41	do.	1960	Aug,Jet	48	48	1¼	m 54	G	227	Top of casing(Alt. 229.89)	2.5	F17.3	5/12/60	O	L;T 50.6;F.
-42	do.	1960	Aug,Jet	37	37	1¼	m 38	G	226	Top of casing(Alt. 230.63)	4.2	F17.4	5/12/60	O	L;T 50.3;F.
-43	N.Y.S. Dept. of Pub. Wks.	1960	Aug,Jet	35	35	1¼	m 37	G	229	Top of casing(Alt. 226.07)	-3.3	F16.8	11/16/60	O	y 20,dd 10,h 1;L;T 51;F.
-44	do.	1960	Aug,Jet	33	33	1¼	m 33	G	229	Top of casing(Alt. 232.12)	3.5	F11.8	5/13/60	O	L;T 61.6;F.
-45	City of Schenectady	1960	Aug,Jet	43	43	1¼	m 43	G	228	Top of casing(Alt. 231.61)	3.8	F17.7	5/16/60	O	L;T 48.8;F.
-46	do.	1960	Aug,Jet	40	40	1¼	m 43	S,G	236	Top of casing(Alt. 237.54)	1.8	F25.9	5/16/60	O	y 25;L;T 59.6;F.
-47	do.	1960	Aug,Jet	52	52	1¼	m 53	S,G	221	Top of casing(Alt. 221.62)	.5	F11.7	5/17/60	O	L;T 50.7;F.
-48	General Electric Co.	1960	Aug,Jet	52	52	1¼	m 53	G	230	Top of casing(Alt. 230.35)	LS	F24	12/29/60	O	L;T 51.5;F.
-49	do.	1960	Aug,Jet	42	42	1¼	m 48	G	231	Top of casing(Alt. 230.82)	LS	F21.8	5/17/60	O	y 25;L;T 49.2;F.
-52	H. Payne	1960	Aug,Jet	30	30	1¼	m 33	G	219	Top of casing(Alt. 220.67)	1.2	F10.1	5/19/60	O	L;T 48.9;F.
-53	Town of Rotterdam	1960	Drl	58	58	6	m 65	S,G	231	Top of casing(Alt. 232.53)	2	F20.5	5/26/60	O	y 30,ddsl;L;T 65.1;F.
-54	do.	1960	Drl	51	51	6	m 51	S,G	229	Top of casing(Alt. 231.99)	3	F19.3	5/27/60	O	y 25,ddsl;L;T 60.0;F.
-55	do.	1960	Drl	43	43	6	m 43	S,G	231	Top of casing(Alt. 233.13)	2.5	F21	6/ 1/60	O	L;T 48.1;F.
-56	do.	1960	Drl	45	45	6	m 45	S,G	234	Top of casing(Alt. 236.43)	2.8	F23.9	6/ 2/60	O	y 30,ddsl;L;T 48.8;F.
-57	City of Schenectady	1960	Drl	40	40	6	m 40	S,G	236	Top of casing(Alt. 239.37)	3.1	F26.4	6/ 2/60	O	L;T 60.3;F.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
249-359-58	City of Schenectady	1960	Drl	56	56	6	m 56	S,G	228	Top of casing(Alt. 230.97)	2.6	F18.2	6/ 3/60	O	L;T 50.2;F.
-59	N.Y.S. Dept. of Pub. Wks.	1960	Drl	44	44	6	m 44	S,G	225	Top of casing(Alt. 229.44)	4.2	F12.7	6/ 6/60	O	y 60,ddsl;L;T 55.6;F.
-60	do.	1960	Drl	51	51	6	m 51	S,G	239	Top of casing(Alt. 239.29)	.4	F27.6	6/ 7/60	O	L;T 60.5;F.
-61	do.	1960	Drl	70	70	6	m 73	S,G	232	Top of casing(Alt. 233.70)	1.8	F23.5	6/13/60	O	L;T 65.8;F.
-62	do.	1960	Drl	30	30	6	m 30	S,G	232	Top of casing(Alt. 234.22)	1.9	F23.8	6/13/60	O	L;T 67.1;F.
-63	City of Schenectady	1960	Drl	40	40	6	m 40	S,G	230	Top of casing(Alt. 233.17)	3	F20.9	6/13/60	O	L;T 48.7;F.
-64	do.	1960	Drl	40	40	6	m 40	S,G	242	Top of casing(Alt. 244.44)	2.2	F30.8	6/15/60	O	L;T 51.0;F.
-66	N.Y.S. Dept. of Pub. Wks.	1960	Jet	6	6	1¼	m 6	G	212	Top of casing(Alt. 216.82)	4.4	F 3.2	7/12/60	O	ddsl,h 0.5;T 64.8;F.
-68	do.	1960	Jet	8	8	1¼	m 8	S,G	213	Top of casing(Alt. 214.60)	1.5	F 4.2	7/13/60	O	y 20,ddsl,h 0.5;T 70.9;F.
-69	do.	1960	Jet	16	16	1¼	m 16	S,G	213	Top of casing(Alt. 217.52)	4	F 3.7	7/15/60	O	y 20,ddsl,h 0.5;T 64.6;F.
-70	do.	1960	Jet	5	5	1¼	m 5	S,G	214	--	.1	+ 0.1	8/16/60	O	y 25,ddsl,h 0.5;T 57.5;F.
-72	City of Schenectady	--	Drl or Dvn	38	38	2	m 38	--	239	Top of casing(Alt. 239.70)	1	F27.8	9/25/61	O	T 62.5;F.
-75	City of Schenectady	1940	Drl	67	47	20-12	m 67	G	227	--	LS	19.2	10/ 4/60	PS	ry 2,060,dd 1;S 20;L;T 64;F;A;Sn 129.
-76	do.	1942	Drl	r 62	43	24-18	m 62	G	230	--	LS	r18	12/ /42	PS	y 3,555,dd 3.3,h 18;S 19;L;A;Sn 130.
-77	do.	1942	Drl	r 70	51	24-18	m 71	G	230	--	LS	r20	12/ /42	PS	y 3,555,dd 6.9,h 18;S 19;L;T 64;F;Sn 131.
-78	do.	1942	Drl	r 70	49	24-18	m 72	G	230	--	LS	r17.5	1/19/43	PS	y 3,570,dd 9.2,h 18;S 21;L;T 60;A;Sn 132.
-79	do.	1942	Drl	r 62	42	24-18	m 67	G	230	--	LS	r17	1/15/43	PS	y 3,570,dd 2.3,h 18;S 20;L;A;Sn 133.
-80	do.	1942	Drl	r 56	37	24-18	m 59	G	230	--	LS	r19.5	2/ 5/43	PS	y 3,600,dd 3.4,h 18;S 19;L;T 64;A;Sn 134.
-81	do.	1942	Drl	r 69	49	24-18	m 71	G	230	--	LS	r18.9	2/10/43	PS	y 3,540,dd 6.9,h 18;S 20;L;Sn 135.
-82	do.	1943	Drl	r 69	50	24-18	m 71	G	229	--	LS	r18.7	2/16/43	PS	y 3,570,dd 2.9,h 18;S 19;L;Sn 136.
-83	do.	1943	Drl	r 67	48	24-18	m 70	G	227	--	LS	r16.3	2/17/43	PS	y 3,570,dd 3.5,h 18;S 19;L;T 62;F;Sn 137.
-84	do.	1943	Drl	r 66	47	24-18	m 67	G	226	--	LS	r14.3	2/22/43	PS	y 3,540,dd 2.9,h 18;S 19;L;T 58;F;A;Sn 138.
-85	do.	1954	Drl	80	80	6	m 81	G	230	Top of casing(Alt. 233.29)	3	21.2	10/15/59	T,O	L;Sn 350.
-86	do.	1953	Dvn,Jet	r 54	54	2½	m 54	G	230	Top of casing(Alt. 231.16)	1.5	20.5	10/15/59	T,O	L;Sn 351.
-87	do.	1953	Dvn,Jet	r 44	44	2½	m 44	G	230	Top of casing(Alt. 231.37)	1.5	F20.7	10/15/59	T,O	L;Sn 352;T 53.0;F.
-88	do.	1953	Dvn,Jet	r 60	58	2½	m 60	G	230	Top of casing(Alt. 231.41)	1.5	20.7	10/15/59	T,O	L;Sn 353.
-89	do.	1953	Dyn,Jet	r 60	60	2½	m 60	G	230	Top of casing(Alt. 230.07)	.5	F20.4	10/15/59	T,O	L;Sn 354;T 51.5;F.
-90	do.	1953	Dvn,Jet	r 45	45	2½	m 45	G	230	Top of casing(Alt. 229.83)	.5	F20.2	10/15/59	T,O	L;Sn 355;T 51.5;F.
-91	Town of Rotterdam WD-5	1949	Drl	r 82	63	16-12	m 82	G	237	Well house floor(Alt. 238.21)	1	r29.6	11/16/60	PS	y 1,083,dd 3.5,h 24;S 19;L;T 59;F;A;Sn 334.
-92	do.	1954	Drl	r 82	62	24	m 84	G	237	Well house floor(Alt. 238.19)	1	r28.5	11/16/60	PS	ry 2,300,dd 4,h 24;S 20;L;T 59;F;A;Sn 339.
-93	do.	1954	Drl	- 81	61	24	m 81	G	237	Well house floor(Alt. 238.24)	1	r3D	11/16/60	PS	ry 1,869,dd 4.5,h 0.5;S 20;L;T 65;F;A;Sn 340.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
249-359-94	City of Schenectady	1954	Drl	r 70	50	36-24	m 70	G	230	--	LS	r22	11/ /54	PS	ry 2,873,dd 2;S 20;L;T 56;F;A;Sn 359.
-95	do.	1954	Drl	r 71	51	36-24	m 72	G	230	--	LS	r20.5	11/ 3/54	PS	ry 2,980,dd 1.5;S 20;L;T 58;F;A;Sn 360.
-96	do.	1895	Dug	r 43	--	96 x 720	m 43	G	241	--	--	--	--	PS,A	Sn 126; total yield 13-14 mgd.
-97	do.	1903	Dug	r 44	44	564	m 44	G	241	--	--	--	--	PS,A	A;Sn 127; total yield 13-14 mgd.
-98	do.	1903	Dug	r 40	40	564	m 40	G	241	--	LS	32.9	9/ 1/60	PS,A	Sn 128; total yield 13-14 mgd.
-99	do.	1931	Drl	r 43	--	6	m 43	S	239	--	--	--	--	T,De	L;CS-1931-A.
-100	do.	1931	Drl	r 40	--	6	m 40	S	227	--	--	--	--	T,De	L;CS-1931-B.
-101	do.	1931	Drl	r 45	--	6	m 45	S,G	225	--	--	--	--	T,De	L;CS-1931-C.
-102	do.	1931	Drl	r 55	--	6	m 55	S	228	--	--	--	--	T,De	L;CS-1931-G.
-106	do.	1931	Drl	r 73	--	6	m 73	G	228	--	LS	r15.3	1931	T,De	L;CS-1931-L.
-107	do.	1931	Drl	r 51	--	6	m 51	G	221	--	LS	r 8.7	1931	T,De	L;CS-1931-M.
-108	do.	1931	Drl	r 62	--	6	m 62	S,G	230	--	LS	r16.9	1931	T,De	L;CS-1931-N.
-109	do.	1931	Drl	r 70	--	6	m 70	G	228	--	LS	r15.3	1931	T,De	L;CS-1931-O.
-110	do.	1931	Drl	r 51	--	6	m 51	G	225	--	LS	r12.7	1931	T,De	L;CS-1931-P.
-111	do.	1931	Drl	r 59	--	6	m 59	G	221	--	LS	r 9	1931	T,De	L;CS-1931-Q.
-112	do.	1931	Drl	r 64	--	6	m 64	G	229	--	LS	r12.6	1931	T,De	L;CS-1931-R.
-113	do.	1931	Drl	r 49	--	6	m 49	G	230	--	LS	r13.5	1931	T,De	L;CS-1931-S.
-114	do.	1931	Drl	r 59	--	6	m 59	G	228	--	LS	r14.2	1931	T,De	L;CS-1931-T.
-115	do.	1931	Drl	r 61	--	6	m 61	G	243	--	LS	r31.3	1931	T,De	L;CS-1931-U.
-116	do.	1927	Drl	r223	--	6	223	S,G	237	--	--	--	--	T,De	L;CS-1927-1;Sn 219.
-117	do.	1927	Drl	r175	--	6	175	S	235	--	--	--	--	T	L;CS-1927-3.
-118	do.	1927	Drl	r112	--	6	112	G	240	--	--	--	--	T	L;CS-1927-4.
-119	do.	1927	Drl	r 46	--	6	m 46	S	239	--	--	--	--	T,De	L;CS-1927-6.
-120	do.	1927	Drl	r 67	--	6	m 67	S,G	237	--	--	--	--	T,De	L;CS-1927-7.
-121	do.	1927	Drl	r 55	--	6	m 55	S	238	--	--	--	--	T,De	L;CS-1927-10.
-122	do.	1927	Drl	r 55	--	6	m 55	S	238	--	--	--	--	T,De	L;CS-1927-11.
-123	do.	1927	Drl	r 40	--	6	m 40	S,G	235	--	--	--	--	T	L;CS-1927-16.
-124	do.	1927	Drl	r 57	--	6	m 57	S,G	231	--	--	--	--	T,De	L;CS-1927-18.
-125	do.	1919	Drl	r 63	--	6	m 63	G	237	--	--	--	--	T,De	L;CS-1919-1.
-126	do.	1919	Drl	r 70	--	6	m 70	S,G	236	--	--	--	--	T,De	L;CS-1919-2.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
249-359-127	City of Schenectady	1919	Drl	r 57	--	6	m 57	G	232	--	--	--	--	T,De	L;CS-1919-3.
-128	do.	1919	Drl	r 58	--	6	m 58	G	232	--	--	--	--	T	L;CS-1919-4.
-129	do.	1919	Drl	r 33	--	6	m 33	G	229	--	--	--	--	T,De	L;CS-1919-5.
-130	do.	1919	Drl	r 47	--	6	m 47	S,G	234	--	--	--	--	T,De	L;CS-1919-6.
-131	do.	1919	Drl	r 69	--	6	m 69	S,G	234	--	--	--	--	T,De	L;CS-1919-7.
-132	do.	1919	Drl	r 70	--	6	m 70	S	235	--	--	--	--	T,De	L;CS-1919-8.
-133	do.	1919	Drl	r 68	--	6	m 68	S,G	240	--	--	--	--	T,De	L;CS-1919-9.
-134	do.	1919	Drl	r 74	--	6	m 74	G	238	--	--	--	--	T,A	L;CS-1919-10.
-135	do.	1919	Drl	r 68	--	6	m 68	S,G	230	--	--	--	--	T	L;CS-1919-11.
-136	do.	1919	Drl	r 50	--	6	m 50	S,G	239	--	--	--	--	T,De	L;CS-1919-12.
-137	do.	1919	Drl	r 62	--	6	m 62	G	236	--	--	--	--	T,De	L;CS-1919-13.
-138	do.	1919	Drl	r 68	--	6	m 68	G	235	--	--	--	--	T,De	L;CS-1919-14.
-139	do.	1940	Drl	r110	--	6	m110	G	231	--	--	--	--	T,De	L;CS-1940-6-5.
-140	do.	1940	Drl	r 98	--	6	m 98	G	230	--	--	--	--	T,De	L;CS-1940-6-7.
-141	do.	1940	Drl	r118	--	6	m118	G	225	--	--	--	--	T,De	L;CS-1940-8-6.
-142	N.Y.S. Dept. of Pub. Wks.	1905	Drl	r 50	--	--	m 50	G	211	--	--	--	--	T	L;N.Y. State Barge Canal Boring 1407-B.
249-400-1	C. and A. Davis	1957	Drl	110	15	6	15	Sh	500	Top of casing	-5	58.9	9/15/59	D	ry 2.
-2	Lefever	--	Drl	r360	--	6	--	Sh	580	Top of casing	2.2	8.7	9/16/59	U	H_2S.
-3	West Hill Water Co.	1949	Drl	r201	56	6	56	G,Sh	600	--	LS	r56.5	1949	PS	ry 33;L;A.
-4	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 52	--	2	m 52	T	510	--	LS	r10	1952	T	L.
-5	do.	1952	Drl	r102	--	2	m102	T	503	--	LS	r 7	1952	T	L.
249-402-1	J. English	1937	Drl	r109	--	6	0	Sh	920	--	--	--	--	D,S	Adequate;H_2S;(Sn-118).
250-352-1	H. Shaffer	1957	Dug-Dvn	12	12	5-1¼	s 12	S,Sh	220	Top of casing	-4	8.4	7/31/59	D	Adequate;A.
-2	W. Sisler	b1900	Dug	13	--	60	8	Sh	240	Top of cinder block curbing	LS	9.2	7/31/59	D	Adequate.
250-353-1	P. Wolfe	1952	Drl	r115	8	6	0	Sh	280	--	--	r 6	--	D	ry 1.5;H_2S,A.
-2	F. Latulipe	b1900	Dug	8	--	24	3	Sh	270	Top of wooden well cover	LS	5.4	7/30/59	D	Adequate.
-3	D. Danes	--	Dug	17	17	30	m 17	T	360	Top of wooden well cover	.3	14.2	7/30/59	D	Inadequate;A.
-4	J. Haskey	1950	Dug	11	--	60	m 11	T	360	Top of concrete cover	LS	5.4	7/30/59	D	Adequate;A.
-5	E. D. Benson	1948	Drl	r 45	13	6	m 45	--	360	--	--	--	--	A	ry 0.33;L;Sn 263;well not completed.
-6	Shopmyer Bros.	--	Dug	r 80	--	72	50	Sh	360	--	--	30.7	6/ 3/48	D	Adequate;L;H_2S;Sn 266.
-7	do.	--	Dug	17	--	36	17	Sh	390	--	LS	9.3	6/ 1/48	D	T 53;Sn 267.
-8	S. A. Danes	--	Dug	13	--	48	m 13	T	360	--	--	--	--	D	T 54;Sn 299.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
250-353-9	S. A. Danes	--	Drl	r142	96	6	96	Sh	360	--	LS	r67?	--	U	L;H_2S;Sn 300.
-10	L. C. Blackburn	1947	Drl	r230	20	6	20	Sh	360	--	LS	r 5	--	D	ry 0.2;L;Sn 303.
-11	W. Schultz	--	Drl	r100	25	6	25	Sh	360	--	--	--	--	U	Inadequate;H_2S;Sn 304.
-12	Griesmer	--	Dug	r 12	--	48	0	Sh	380	--	--	--	--	D	Sn 305.
-13	F. Dawson	--	Dug	r 26	--	48	3	Sh	400	--	--	--	--	D	T 57;Sn 306.
250-354-1	R. Chamberlain	1959	Drl	174	20	6	20	Sh	310	Top of casing	-2.5	24.8	7/30/59	D	H_2S.
-2	G. Abbale	--	Dug	12	12	2 x 5	m 12	T	320	Top of concrete well curbing	LS	6	7/30/59	D	Adequate;A.
250-355-1	R. Chambers	1954	Drl	r 21	21	6	m 21	S,G	220	--	LS	r12	--	D	ry 5.
-2	K. Sarnowski	a1900	Dug-Dvn	15	15	12-1¼	m 15	S,G	230	Top of 12-inch tile	-5	13.3	7/16/59	D	Adequate for three families.
-3	do.	--	Dug	4	4	--	m 4	T	270	Iron well-cover collar bottom	LS	p 2.9	7/16/59	C	ry 5;A.
-4	V. Bienduga	1919	Dug	19	--	36	m 19	S,G	290	Top of concrete well curbing	-6	16	7/16/59	D	Adequate;A.
-5	D. H. Mills	1944	Drl	r 75	8	8	8	Sh	300	--	LS	r17	1944	D	ry 2,dd 53,h 0.25;Sn 194.
250-356-1	P. Giaquinto	1955	Dvn	r 15	12	1¼	m 15	S	310	--	--	r11.5	--	D	Inadequate;S 3.
-2	W. Champeau	1954	Dvn	9	6	2	m 9	S	310	Top of reducer on 2-inch pipe	1.7	4.4	7/14/59	D	ry 4;S 3.
-3	T. Boyhan	1954	Dug	12	12	10	m 12	S,G	320	Top of 10-inch tile	LS	10.5	7/14/59	Ir	Adequate;A.
-4	J. Cervera	1953	Dvn	21	19	1¼	m 21	S,G	320	Top of casing	-3	16.7	7/15/59	D	Adequate,used for swimming pool;S 2;A.
-5	Town of Glenville	1952	Dug	21	21	48	m 21	S,G	320	Recess for well cover	LS	18.6	7/15/59	In	y 250,dd 0.5,h 6;A.
-6	S. Nacewicz	1942	Dug	9	9	18	m 9	S	300	Top of 18-inch tile	-3	5.4	7/15/59	D	Adequate.
-7	I. Piotrowski	1949	Dvn	25	22	2	m 25	S	270	Top of casing	-5.5	17	7/15/59	D,S	Adequate;S 3;A.
-8	---	--	Drl	r 36	36	6	m 36	S	320	--	--	--	--	D	ry 25;L;Sn 12.
-9	---	--	Drl	r 42	42	6	m 42	S	320	--	--	--	--	D	ry 25;L;Sn 13.
-10	---	--	Dvn	r 44	--	2	m 44	S,G	320	--	--	--	--	D	Adequate;S unknown;L;Sn 14.
-11	Sarnowski Farm	1918	Drl	r220	70	12	70	Sh	240	--	--	--	--	C	ry 5,dd 210;L;Sn 143.
-12	Pepsi-Cola Co.	1946	Drl	r 50	--	8	m 50	S	310	--	LS	r 4	3/ /46	I	ry 150,dd 13,h 15;S unknown;Sn 144.
-13	do.	1946	Drl	r 52	--	8	m 52	S	310	--	LS	r 4	3/ /46	I	ry 100,dd 10,h 24;Sn 145.
-14	do.	1946	Drl	r 50	--	8	m 50	S	310	--	LS	r 4	3/ /46	I	ry 150,dd 12,h 16;Sn 146.
-15	Glenville WD-9	1959	Drl	r 35	29	12	34	S	320	--	LS	r20.2	10/12/59	PS	ry 76,dd 5,h 24;S 5;L.
250-357-1	J. Deamer	--	Drl	22	8	6	8	Sh	260	Top of casing	1	4.9	7/14/59	D	Adequate.
-2	F. DeLuccia	1950	Drl	126	8	6	2	Sh	260	Top of casing	-3.5	61.3 ?	7/14/59	D	Inadequate.
-3	do.	a1900	Dug	10	0	42	2	Sh	260	Cellar floor	-5	9.5	7/14/59	D	Inadequate;A.
-4	H. Crandall	--	Drl	32	--	6	2	Sh	270	Top of casing	-1	27.5?	7/14/59	D	Do.
-5	A. Roeters	1957	Drl	r 40	10	6	0	Sh	340	--	LS	r 7.2	7/ /59	D	ry 5;A.
-6	J. Masilunas	1943	Drl	r105	6	8	6	Sh	260	--	LS	r15	1943	D	ry 3.5,dd 60,h 0.25;L;Sn 189.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
250-358-1	Village of Scotia	1958	Drl	r 98	74	14	m 98	S,G	280	Floor of well house	LS	48	11/ 9/60	PS	ry 1,100,dd 20;S 24.
-2	do.	1938	Drl	r 70	46	24-12	m100	S	270	--	LS	r26	1945	PS	ry 1,500;S 25;L;A;Sn 4.
-3	Cushing Stone Co.	1927	Drl	r175	90	8	90	Sh	300	--	--	--	--	I,A	ry 150;L;Sn 9.
-4	do.	1927	Drl	r210	112	8	112	Sh	300	--	LS	r55	1927	A	ry 150;Sn 149.
-5	City of Schenectady	b1928	Drl	r111	--	--	111	Sh	285	--	--	--	--	T	Sn 223.
-6	Martinec Meat Packing Co.	1938	Drl	r180	180	6	180	G	300	--	LS	r40	1938	De	ry less than 30;L;Sn 7.
-7	do.	1945	Drl	r1,000	135	8	135	Sh	300	--	LS	r53	3/ /45	De	ry 10,dd 497;h 2;L;Sn 8.
-8	do.	1946	Drl	136	132	8	m136	G ?	300	--	LS	r80	--	De	ry 2,dd 45;T 50;Sn 152.
-9	U. S. Naval Depot	1943	Drl	r202	172	20-12	203	S,G	290	--	LS	r56.5	7/18/45	C	ry 1,265,dd 38,stand-by use;S 30;L;A;Sn 1.
-10	Village of Scotia	1943	Drl	r 85	55	12	m 85	S,G	270	Pump foundation	-2	r30	3/10/43	PS	ry 1,150,dd 13,h 24;S 31;L;A;Sn 5.
-11	do.	1929	Dug	45	45	108 x 158	m 45	S,G	261	Pump room floor	-16	r20.6	5/ 1/61	A	Sn 153.
250-359-1	H. Timmerman	1955	Drl	r 75	75	6	m 75	S,G	270	--	--	--	--	D	Adequate;L.
-2	E. Clapper	--	Dug	24	24	36	m 24	S,G	235	Top of casing	LS	13.3	6/16/59	D	Adequate.
-3	A. Hitchins	--	Dug	4	--	--	--	T,Sh	300	--	LS	Flowing	6/23/59	D	Flowing y 0.5;adequate;A;T 50.
-4	Cushing Sand & Gravel Co.	--	Drl	54	54	6	m 54	S,G	280	Top of casing	-5.4	45.7	6/11/59	A	
-5	A. Buchanan	--	Drl	42	42	6	m 42	S,G	260	Top of casing	-4.2	40.2	6/30/59	D	Adequate.
-6	F. Glindmeyer	--	Dug-Dvn	r 57	57	24-1¼	m 57	S	270	--	LS	r40	--	D	Adequate;L;A.
-7	N. Coutant	--	Dug	22	22	30	m 22	S,G	240	Top of concrete tile	2.1	13.3	7/28/59	D	Inadequate in winter;A.
250-400-1	A. Baan	b1900	Dug	21	0	36	m 21	S,G	250	Bottom of wooden well cover	LS	15.8	6/23/59	D	Inadequate.
-2	do.	1945	Dug	14	0	55	m 14	S,G	235	Top of concrete well cover	LS	5.5	6/23/59	Ir	ry 250,dd 8,h 0.33,inadequate.
-3	W. Vrooman	1955	Drl	50	35	8	m 76	S,G	230	Top of casing	LS	F12.4	8/18/59	T,O	ry 440,dd 14,h 34;S 15;L;T 46.1;F;Sn 357.
-4	do.	--	Drl	50	50	5	m127	S,G	235	Top of casing	.3	13.3	8/ 6/59	T,O	L;casing pulled back to 50 ft;Sn 358.
-5	J. Oddy	1957	Drl	. 60	60	6	m 60	S,G	240	Top of concrete well curbing	.9	14.5	6/24/59	D	Adequate;H_2S.
-6	W. Vrooman	--	Dug	24	--	36	m 24	S,G	235	Top of concrete block	.6	13.6	6/26/59	D	Adequate.
-7	F. Vrooman	--	Dug	3½	--	42 x 54	a 3	T,Sh	300	--	LS	.5	6/26/59	D	ry 1,inadequate;T 54.
-8	do.	--	Dug	5	--	60	s 5	T,Sh	300	--	LS	2.2	6/26/59	D	H_2S.
-9	do.	1953	Drl	r 72	72	6	a 10	Sh	285	--	--	--	--	D	Adequate;H_2S.
-10	W. Vrooman	1912	Drl	35	35	6	m 35	S,G	230	Top of wooden pump base	1	15.2	9/15/59	D	Adequate;A.
-11	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 18	--	2	m 18	S,G	363	--	--	--	--	T	L.
-12	do.	1952	Drl	r 35	--	2	30	G,T	360	--	LS	r 3	1952	T	L.
250-401-1	E. Shannon	--	Dug	28	28	42	m 28	T	260	Top of concrete well cover	.4	25.7	6/24/59	D	Inadequate.
-2	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 67	--	2	m 67	T	307	--	LS	r14	1952	T	L.
250-404-1	H. Goodnow	a1940	Dug	6	--	32	m 6	T	1,295	Top of wooden casing	-3.2	4.1	6/28/45	D	Adequate;Sn 72.
251-353-1	C. Matthews	1939	Dug	21	0	36	m 21	T	290	Top of wooden well cover	2.8	9.2	7/17/59	D	Inadequate;A.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
251-353-2	C. Schaus	1929	Drl	99	99	6	m 99	S	300	Top of casing cover	-4.5	68.6	9/24/59	D	ry 10,adequate;L.
-3	R. Schaus	1953	Drl	105	105	6	m105	S	315	Top of coupling	.5	91.9	9/24/59	D	ry 5;L.
-4	G. Wolfrom	1943	Drl	r183	124	8	124	Sh	250	--	LS	r31	1943	D	ry 5,dd 119,h 0.33;L;Sn 196.
-5	W. Bruce	1943	Drl	r115	73	8	73	Sh	290	--	LS	Flowing	1943	D	Flowing ry 1;L;H_2S;Sn 140.
251-354-1	D. Orminski	--	Dvn	r 26	23	2	m 26	S	260	Top of casing	-4	r14	--	D	Adequate;S 3;A.
-2	do.	--	Dug	8	8	24	m 8	S	260	Recess for iron well cover	1	4.8	7/16/59	U	
-3	S. Smirowski	--	Dug	4	4	24	m 4	S	250	Top of tile	1.5	.3	--	D	Adequate;A;T 55.
-4	L. Rix	b1900	Dug	24	--	42	a 21	Sh	230	Top of wooden well cover	.7	18.9	7/16/59	D	Adequate.
-5	do.	b1900	Dug	21	--	42	s 21	Sh	230	Top of wooden well cover	.7	17.4	7/16/59	S,Ir	Adequate;H_2S,A.
-6	R. Boucher	1957	Drl	r 92	92	6	m 92	S,G	230	--	LS	11.8	1957	D	ry 12.
-7	W. Fowler	--	Dug	11	11	24-30	m 11	S	230	Top of tile	1	7.8	7/17/59	D	Adequate for three houses;A.
-8	C. Corlea	1932	Dug	8	--	20	m 8	T	220	Top of tile	1	6.5	7/16/59	A	Inadequate;H_2S.
-9	G. Dingley	1957	Dvn	r 80	80	6	m 80	S,G	260	--	--	--	--	D	ry 30;L;H_2S.
-10	A. Dudek	--	Dug	27	27	36	m 27	S	270	Top of tile	-5	23.5	7/17/59	D	Adequate.
-11	do.	1959	Dug	24	24	36	a 70	S	270	Top of tile	-2.5	18.9	7/17/59	D	Adequate;A;T 51.1.
-12	Glenville WD-7	1959	Drl	r 69	69	8	69	Sh	280	--	LS	r55	1959	PS	ry 8;L;A.
-13	do.	1960	Drl	r 65	65	6	m 65	S,G	280	--	LS	r32	1960	PS	ry 10,dd 25,h 128;L;A.
-14	do.	1960	Drl	r 93	93	8	m 93	S,G	290	--	LS	r46.2	1960	PS	ry 9;L.
-15	do.	1960	Drl	r 48	48	6	m 48	S,G	315	--	LS	r31.5	1960	T,O	L.
-16	do.	1960	Drl	r 40	33	6	33	Sh	320	--	LS	r 6	1960	T,O	L.
-17	W. A. Pelrine	1937	Dvn	r 28	25	2	m 28	S	230	--	--	--	--	D	Adequate;S 3;slight H_2S;Sn 141.
-18	E. Dawson	1927	Drl	r143	95	8	95	Sh	230	--	--	--	--	D	Adequate;Sn 142.
-19	F. Mott	1937	Drl	r110	77	6	77	Sh	220	--	LS	r10	5/ /37	D	ry 3;L;Sn 195.
-20	F. Bundy	1946	Drl	r 71	71	6	m 71	G	245	--	LS	r33	3/ /46	D	ry 8,dd 27,h 0.5;L;Sn 188.
-21	Glenville WD-7	1961	Drl	r 83	83	6	m 83	S	285	--	--	--	--	PS	ry 4.
251-355-1	H. Sanders	1959	Drl	r243	--	6	3	Sh	360	--	LS	r 3	8/ /59	D	ry 1.
-2	General Electric Co.	1945	Drl	r225	21	10	21	Sh	340	--	LS	r 8	1945	C	ry 2;L;Sn 10.
-3	do.	1945	Drl	r150	15	6	15	Sh	340	--	--	--	--	C	ry 7;T 55;L;A;Sn 11.
251-356-1	J. Roberts	1936	Dug	15	15	30	m 15	S	360	Cellar floor	-5	12.8	7/ 2/59	D	Adequate;A.
-2	G. Faulkner	1950	Dvn	r 24	21	2	m 24	S,G	360	--	LS	r18	1950	D	Adequate;S 3.
-3	H. Komoroske	1956	Dvn	24	21	$1\frac{1}{4}$	m 30	S,G	360	Top of casing	-3	19.2	7/ 8/59	D	Adequate;S 3;L.
-4	L. Hidenrich	--	Dug	22	--	36	m 22	S	360	Top of concrete well curbing	LS	18	7/ 8/59	D	Adequate.
-5	R. Hollenbeck	1946	Dug	24	24	36	m 24	S,G	320	Top of tile	LS	19.9	7/15/59	Ir	ry 15,ddsl,h 8.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
251-356-6	S. Godell	1948	Dvn	22	19	1¼	m 22	S	350	Top of casing	-2.5	17.1	7/22/59	A	Inadequate;S 3.
-7	R. Hayner	1950	Drl	r125	125	6	s125	Sh	350	--	--	--	--	D	Adequate.
-8	W. Tragert	1960	Drl	r 81	70	6	70	Sh	340	Top of casing	-4.5	r 4.5	5/10/60	D	ry 10;H_2S.
-9	Schenectady County Airport	--	Drl	r 46	44	6	44	Sh	325	--	LS	r12	--	C	ry 10;L.
-10	do.	1936	Dvn	31	28	2	m 31	S	320	Top of casing	.4	21.5	7/19/45	C	Adequate;S 3;Sn 3.
-11	Town of Glenville	1957	Drl	r 80	69	8	m 84	S,G	330	--	LS	r29	9/ 3/57	T	ry 350,dd 34,h 25;S 11;A;L;T 51.
-12	Glenville WD-9	1960	Drl	r 35	28	10	35	S	320	--	LS	r16	4/28/60	PS	ry 80,dd 5.5,h 72;S 7;L.
251-357-1	D. Larned	--	Dug	25	--	36	m 25	S,G	380	Top of concrete curbing	1.8	23.3	7/ 2/59	D	Adequate;A.
-2	N. Bertolet	1941	Dug	19	10	24	10	Sh	390	Top of tile	.8	8.2	7/ 2/59	D	Do.
-3	L. Horstman	--	Dug	24	--	30	m 24	S	330	Top of concrete curbing	.9	19.9	7/ 8/59	C	Adequate.
-5	T. Cieslak	b1930	Dug	12	--	36	m 12	S	340	Top of wooden cover recessed in concrete curbing	.2	10.4	7/ 8/59	U	
-6	H. Campbell	1956	Dug	20	--	54	2	Sh	390	Top of concrete well cover	2	11.9	7/ 9/59	D	Adequate.
-7	Proposed Glenville WD-10	1961	Jet	r 30	27	1¼	m 36	S	360	--	LS	r 5	10/ /61	PS	ry 12;six wells given one number, total yield 70;dd 15,h 4;S 3;A.
251-358-1	D. Hill	--	Drv	8	--	--	--	T	300	--	LS	Flowing	6/30/59	D	Flowing y 1;A;T 51.8;developed spring.
-2	F. Fuller	1953	Dug	22	22	36	m 22	T	300	Top of concrete curbing	.7	17.6	6/30/59	D	Adequate;A.
-3	S. Siematkowski	--	Dug	16	16	24	16	Sh	360	Top of tile	.2	14.6	6/30/59	D	Inadequate;A.
-4	J. Joralemon	b1935	Dug	10	10	18	m 10	T	380	Top of tile	1.9	4.2	6/30/59	D	Adequate;A.
-5	D. Romand	1938	Dug	31	30	36	m 31	T	269	Top of air pipe	.7	20.6	6/30/59	D	Inadequate;A.
-6	W. Dalton	--	Dug	--	--	--	--	T	280	--	LS	Flowing	6/30/59	D	Flowing ry 3;A;T 51.8;developed spring.
-8	D. Preddice	1953	Dug	28	28	36	m 28	T	330	Recess for well cover	LS	7.4	7/ 1/59	D	Adequate;A.
-9	J. Desantis	1959	Drl	75	24	6	24	Sh	340	Top of casing	LS	36	7/ 1/59	T,A	ry 4;L;H_2S.
-10	do.	1959	Drl	82	27	6	27	Sh	340	Top of casing	.8	39.2	7/ 1/59	T,A	y 3;L;H_2S;A.
-11	R. Lefebure	1948	Dug	22	8	24	3	Sh	465	Top of tile	1	16.6	7/ 1/59	D	Adequate;A.
-12	D. Romand	1959	Dug	17	--	78 x 114	10	Sh	360	Top of cinder block curbing	LS	12.4	9/17/59	D	Adequate;L.
-13	F. Finch	1944	Dug	26	26	32	m 26	T	420	--	--	m26	--	D	Inadequate,dry 9/24/59.
-14	do.	1960	Drl	r 42	37	6	37	Sh	415	--	LS	Flowing	1960	D	Flowing,adequate.
-15	---	--	Drl	r 60	60	6	60	T,Sh	370	--	--	--	--	D	ry 1;L;H_2S;Sn 19.
-16	---	--	Drl	r140	80	6	80	Sh	450	--	--	--	--	D	ry 0.5;L;some H_2S;Sn 20.
251-359-1	A. Andresen	1929	Dvn	43	40	1¼	m 43	S,G	270	Top of casing	-11.5	34.8	6/25/59	D	Adequate;S 3.
-2	R. Hutchison	1940	Dug	5	--	48 x 96	m 5	T	290	Top of concrete well curbing	2	1.1	6/26/59	D,S	Adequate.
-3	do.	--	Dug	16	--	48	m 16	T	290	Top of iron beam across stone lining	-2	11.7	6/26/59	A	

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

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251-359-4	R. Hutchison	--	Dug	20	--	48	m 20	T	290	--	LS	14.6	6/26/59	A	H_2S.
-5	H. Cath	--	Dug	22	22	24	m 22	S,G	260	Top of tile	LS	19.5	6/30/59	U	A.
-6	J. Estenes	1951	Dvn	r 40	37	1¼	m 40	S,G	260	Top of concrete curbing	-5.6	r29	6/30/59	D	Adequate;S 3;A.
-7	P. Jordan	1943	Dug	r 21	--	24	m 21	T	410	Top of concrete curbing	LS	12.1	7/ 2/59	D	Adequate;A.
-8	J. Woodman	--	Dug	20	--	23	10	Sh	540	Top of concrete curbing	-4.5	8.6	7/ 2/59	D	Inadequate;A.
-9	do.	1957	Drl	r 60	5	6	4	Sh	540	--	LS	r 8	1957	D	ry 6;L.
251-400-1	L. Jeffers	1913	Drl	r182	182	6	m182	S,G	260	--	LS	Flowing	--	D	Flowing y 1,adequate;H_2S.
-2	L. Day	1920	Dug	28	28	36	m 28	G	260	Top of concrete casing	LS	27.2	6/16/59	D	Inadequate in winter.
-3	A. Kramer	--	Dug	35	35	24	m 35	S,G	260	Top of wooden well cover	-4.8	29.1	6/16/59	D	Do.
-4	A. Hickin	1952	Drl	88	88	6	m 88	S,G	260	Top of concrete well pit	LS	50.1	6/16/59	D	Adequate.
-5	J. Horstmyer	1938	Drl	41	41	6	m 41	S	260	Top of casing	-5.5	31.2	6/16/59	D	Do.
-6	D. Groat	1954	Drl	r175	175	6	m175	S,G	265	Top of casing	-6.2	43.9	6/17/59	D	Do.
-8	G. Thayer	1951	Dug	22	22	36	m 22	T	300	Bottom of concrete well cover	1.7	13.6	6/25/59	D	Adequate.
-9	S. Wissik	1954	Drl	43	43	6	m 43	S,G	255	Top of casing	-4.8	26.2	6/25/59	D	Do.
-10	F. Widmer	1955	Drl	r325	a250	6	a250	Sh	260	Top of cover plate	-4	11.2	6/26/59	D	ry 0.5;H_2S,A.
-11	do.	--	Drl	r 90	a 90	6	m 90	S	260	--	--	--	--	D	Adequate;L.
-12	A. Whitford	b1900	Dug	38	--	42	m 38	S,G	280	Top of recess for well cover	LS	6	6/26/59	D	ry 15.
-13	H. Hill	1956	Drl	r316	198	6	198	Sh	265	--	LS	r10	9/ /56	D	ry 25;L.
251-401-1	E. Babcock	--	Dug	17	--	28	m 17	T	260	Top of concrete curbing	LS	13.2	6/16/59	D	Inadequate in summer.
-2	S. Johnson	1941	Drl	39	--	6	m 39	S,G	250	Top of casing	-5.3	m39	6/18/59	U	Dry
-3	H. Floyd	1938	Dvn	40	37	2	m 40	G	250	Top of casing	-2	38.4	6/18/59	U	S 3.
-4	H. Sittner	--	Dug	21	21	30	m 21	T	265	Bottom of wooden well cover	LS	18.8	6/24/59	A	
-5	G. O'Loughlin	b1900	Dug	4	--	26 x 32	m 4	--	260	Top of concrete curbing	1.9	2.5	6/24/59	D	Inadequate in summer.
-6	E. France	1959	Drl	r360	--	6	--	Sh	425	Top of casing	2.3	36.9	6/24/59	D,U	
-7	L. Brunnelle	1949	Dug	22	22	32	m 22	S	295	Top of concrete tile block	.8	16.6	6/24/59	D	Adequate;L.
-8	A. Eaton	1949	Drl	r463	244	6	244	Sh	250	--	LS	Flowing	12/26/49	U	Flowing y 1;L;gas;A;T 52.5;Sn 337.
-9	---	--	Dug	38	--	36	m 38	S,G	250	Depression for pump base in concrete well cover	LS	33.5	6/26/59	D	
-10	E. Shanty	1958	Dug	12	--	--	m 12	T	300	Cellar floor	-4.5	8.5	7/29/59	D	Adequate.
-11	Town of Glenville	1957	Drl	51	41	12	m 55	S,G	237	Top of casing	LS	F 9.6	10/20/60	T	ry 740,dd 0.6,h 4;S 10;L;A;T 50.
-12	R. Decker	--	Drl	r100	100	6	m100	T	350	Top of casing	-6	76.1	5/10/61	D	Adequate.
-13	do.	1960	Drl	r 46	46	6	m 46	T	340	--	LS	r31.6	5/10/61	U	ry 0.5,inadequate.
-14	do.	1961	Drl	r108	108	6	m108	T	340	--	--	--	--	U	Inadequate(reported dry).

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
251-401-15	Schenectady Chemical Co.	1942	Drl	52	37	12	m 52	S,G	240	Air gage 3 ft above pump-house floor	LS	11	9/14/60	I	ry 350,dd 1,h 24;S 15;T 50;Sn 212.
-16	do.	1959	Drl	r 47	37	24-16	m 50	S,G	240	--	LS	r33.5	1959	I	ry 1,500,dd 3;S 10;L.
-17	do.	1952	Drl	r 45	40	12-8	m 47	S,G	255	--	LS	r26	1/ 4/52	I	ry 226,dd 11;S 5;L;Sn 341.
-18	do.	1951	Drl	r 46	36	18-12	m 48	S,G	255	--	LS	r26	10/18/51	I	ry 777,dd 5;S 10;L;Sn 342.
-19	Glenville School Dist.-3	1923	Drl	r321	227	6	227	Sh	260	--	LS	Flowing	1923	In	Flowing y 5;A;T 50;Sn 191.
-20	Boston & Maine Railroad Co.	a1918	Dug	r 20	--	240	m 20	S,G	240	--	LS	r14	2/ /61	U	ry 500;water level about equal to Mohawk River level Sn 110.
-21	H. Snyder	1940	Dug	14	14	18	m 14	T	380	Top of wooden cover	0.7	11.8	6/28/45	D	Inadequate;Sn 74.
-22	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 62	--	2	m 62	S	398	--	--	--	--	T	L.
-23	do.	1952	Drl	r 20	--	2	0	Sh	319	--	--	--	--	T	L.
-24	do.	1952	Drl	r 18	--	2	13	Sh	357	--	LS	r 4	1952	T	L.
251-402-1	E. Candage	--	Dug	33	--	36	m 33	S,G	250	Bottom of concrete well cover	LS	26.4	6/18/59	U	
-2	W. Schipper	1929	Dug	6	--	60	m 6	T	1,000	Top of wooden cover	LS	3	6/28/45	D	Adequate;Sn 73.
252-354-1	K. Nussbaumer	1949	Dug	19	19	36	m 19	S	250	Top of tile	1	17.9	7/21/59	D	Adequate.
-2	F. Stodgell	b1900	Dug	4	4	36 x 48	m 4	S	290	Top of concrete curbing	1	2.4	7/21/59	D	Do.
-3	---	1959	Dug	9	9	36	m 9	S	250	Top of tile	LS	8	7/22/59	D	Do.
-4	E. Slater	--	Dug	2	--	48 x 48	m 2	S	260	Top of wooden well cover	LS	.5	8/ 7/59	D	y 3;T 53.
-5	Glenridge Hospital	1957	Jet	13	13	1	m 13	S,G	230	Top of casing	2.5	10.3	9/24/59	O	A.
-6	do.	1957	Jet	r 17	14	4	m 17	S,G	230	--	--	--	--	In	Seven identical wells with one number, combined y 200,dd 8,h 96;S 3;A.
-7	O. Pahl	--	Dvn	15	12	1¼	m 15	S	350	Top of casing	-2.2	15.2	7/22/59	U	S 3.
-8	H. Blair	1943	Drl	92	--	6	m 92	S	300	--	LS	r25	--	D	ry 4;L;Sn 155.
-9	do.	1943	Drl	130	--	6	130	S,Sl	300	--	--	--	--	D	L;Sn 156.
-10	do.	1943	Drl	90	--	6	75	Sh	300	--	--	--	--	D	L;Sn 157.
-11	B. Condon	--	Drl	r 85	85	6	85	Sh	330	--	--	--	--	D	ry 5;L;Sn 24.
-12	Cozy Dale Farm	1905	Drl	r108	68	6	68	Sh	230	--	LS	r20	1931	S	H_2S;Sn 147.
252-355-1	R. Ashley	1951	Dug	11	3	36	3	Sh	360	Top of concrete tile	LS	6.4	7/22/59	D	Inadequate.
-2	S. Yeomans	1948	Dug	18	--	6	18	Sh	360	Top of casing	-5.3	8.8	7/22/59	D	Adequate.
-3	O. Pahl	--	Dvn	18	15	1¼	m 18	S	350	Top of casing	3.3	16.3	7/22/59	D	Adequate;S 3.
-4	G. Sutherland	1945	Drl	r 70	11	6	7	Sh	400	--	LS	r 7	1945	D	ry 1;L.
-5	D. MacCracken	1953	Dug	14	9	30	9	Sh	340	Top of concrete curbing	.5	12.1	7/23/59	D	Adequate.
-6	J. Potter	1950	Dug	11	--	42	m 11	T	350	Cellar floor	-4.5	8.8	7/23/59	D	Inadequate.
-7	R. Elwell	1951	Dug	13	--	--	5	Sh	370	Top of concrete curbing	-4.5	6.7	7/23/59	A	
-8	do.	1952	Drl	60	7	6	7	Sh	370	--	LS	r13.6	1952	D	ry 4;L;H_2S.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
252-355-9	W. Horan	--	Dvn	7	4	2	m 7	S	350	Top of pipe	1.8	4.2	9/17/59	D	Adequate.
-10	Glenville WD-4	--	Dug	r 9	--	108 x 600		Si,Cl	290	--	LS	Flowing	--	PS	ry 25;A.
252-356-1	C. Ladue	--	Dug	r 18	--	--	m 18	T	380	--	LS	r 8	1959	D	Inadequate.
-2	R. Hyland	--	Dvn	11	8	1¼	m 11	S	340	Top of opening in brass cap	-4	9.5	7/ 8/59	D	Adequate;S 3.
-3	E. Roberts	1927	Dug	4	4	24	m 4	Cl	380	Top of tile	1.8	2.5	7/ 8/59	D	Adequate.
-4	R. Down	1958	Dug	19	19	60	m 19	S,G	380	Top of concrete well cover	-2.5	10.5	7/ 8/59	U	ry 4,dd 2,h 3;L.
-5	B. Van Flue	1945	Dug	13	13	24	m 13	T	390	Top of tile	1.7	8.2	7/ 9/59	D	Inadequate.
-6	O. Walrath	1946	Dug	10	10	48	m 10	S	380	Top of recess for well cover	LS	7	7/10/59	D	Do.
-7	Baldwin Droms, Inc.	1959	Dvn	14	11	1¼	m 14	S,G	350	Top of casing	4	9.3	7/14/59	D	ry 5;S 3.
-8	Glenville WD-5	1959	Drl	r 22	19	8	17	S,G,Sh	350	--	LS	r 5	1959	PS	y 20,dd 7;S 3;L;A.
-9	do.	1959	Drl	r 24	18	6	18	S,G,Sh	350	--	LS	r 5	1959	PS	ry 14;L;A.
-10	do.	1959	Drl	r 24	18	6	18	S,G,Sh	350	--	LS	r 5	1959	PS	ry 20;L same as -9;A.
-11	do.	1959	Drl	r 24	18	6	18	S,G,Sh	350	--	LS	r 5	1959	PS	ry 10;L same as -9;A.
-12	---	--	Drl	r 44	44	6	m 44	S	347	--	--	--	--	D	ry 20;Sn 18.
-13	---	--	Drl	r 66	66	6	m 66	S,G	380	--	--	--	--	D	ry 50;Sn 15.
-14	S. Stewart	a1955	Drl	r106	70	6	70	Sh	345	--	LS	r10	1955	D	y 5;L.
252-357-1	L. Chernik	1952	Dug	11	11	18	m 11	T	390	Top of tile	-4.5	7.6	7/ 1/59	D	Adequate;A.
-2	C. Casagrand	1946	Dug	11	11	36	m 11	T	415	Top of tile	1.6	8.8	7/ 1/59	D	Inadequate;A.
-3	O. Nadler	--	Dug	14	--	54	m 14	S,G	400	Top of concrete well cover	LS	9.1	7/ 1/59	D	Adequate.
-4	F. Ramsey	1952	Dug	9	--	48 x 60	1	Sh	425	Top of wooden curbing	LS	5.5	7/ 2/59	D	Inadequate;A.
-5	C. Grundhoeffer	1941	Dug	8	3	60	3	Sh	400	Recess for wooden well cover	3	3	7/10/59	D	Adequate.
-6	A. Cooper	1955	Drl	r 52	12	6	0	Sh	450	--	--	--	--	D	ry 10;H_2S.
252-400-1	N. Gower	--	Dug	12	--	48	m 12	T ?	500	Top of wooden well cover	.6	5	6/12/59	D	Adequate.
252-401-1	P. Gay	1940	Drl	21	21	8	m 21	S,G	240	Top of casing	-5	14	6/12/59	D	Adequate for swimming pool.
-2	do.	--	Dug	4	--	28 x 38	m 4	S,G	250	Top of concrete block lining	.7	2.3	6/12/59	U	
-3	J. MacFarlane	1959	Dug	5	5	24	m 5	T	320	Top of concrete well cover	LS	.8	6/12/59	D,Ir	Adequate.
-4	E. Matthews	1929	Dug	15	--	30 x 54	a 4	Sh	525	Top of concrete well curbing	-3.5	6	6/12/59	Ir	Adequate for garden.
-5	M. Slover	1955	Dug	10	10	24	m 10	S,G	290	Top of concrete tile	1.2	7.3	6/16/59	D	Adequate.
-6	R. Simmons	1945	Dug	14	--	42	m 14	S	285	Top of concrete well cover	.3	11.5	6/25/59	D	Do.
-7	E. Seca	1952	Drl	r195	--	9	m195	S	245	--	LS	r20	6/25/59	D	Do.
-8	P. Gay	a1938	Drl	r169	169	6	m169	S	260	--	--	--	--	D	Adequate;Sn 86.
252-402-1	M. Swirski	1935	Drl	r100	100	6	m100	S,G	260	Top of casing	-4	r22	6/ 9/59	D	Adequate.
-2	N.Y.S. Dept. of Pub. Wks.	1950	Dug	19	19	30	m 19	S,G	250	Top of casing	-4.5	17.2	6/25/59	U	

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
252-402-3	M. DeLuke	--	Drl	61	61	6	m 61	S,G	300	Top of casing	-4	36.9	6/25/59	D	Adequate.
-4	Acme Oil Co.	--	Dug	6	6	36	m 6	S,G	240	--	LS	Flowing	7/29/59	C	Flowing y 1.8;A;T 52.
-5	D. Stark	--	Drl	r 50	50	6	m 50	--	300	--	--	--	--	A	Inadequate.
-6	E. Van Antwerp	b1900	Dug	45	--	--	m 45	S	260	Top of concrete well base	LS	33.6	7/29/59	A	
-7	F. Ferradino	1954	Drl	r180	121	4	121	Sh	280	Top of casing	-3.5	8.1	7/29/59	D	Adequate.
-8	do.	--	Dug	14	14	24	m 14	T	270	Top of tile	2.5	8.1	7/29/59	A	
-9	M. Tiffney	--	Dug	24	24	42	m 24	S,G	240	Recess for iron well cover	LS	17.5	9/22/59	U	
-10	N.Y.S. Dept. of Pub. Wks.	1958	Drl	r149	149	6	m149	S,G	240	Top of wooden drain boards	LS	+2.7	9/22/59	In	ny 12;y 20,dd 2.5,h 24;L.
-11	do.	--	Dug	r 2	--	--	m 2	S,G	240	--	LS	1.1	9/22/59	U	T 52.
-12	Town of Rotterdam WD-3	1960	Drl	55	58	6	m 61	S,G	260	Top of casing	2.6	F29.9	6/15/60	O	L.
-13	do.	1957	Drl	74	71	1¼	m 74	S,G	260	Top of casing	.5	30.8	12/ 1/60	O	S 3.
-14	do.	1957	Drl	78	75	2	m 78	S,G	260	Top of casing	.5	32.5	12/ 1/60	O	S 3.
-15	do.	1957	Drl	r 86	74	12	m 88	S,G	260	Air line	LS	32	12/ 1/60	PS	y 520,dd 0.7,h 24;S 12;L.
-16	do.	1947	Drl	r 63	51	8	m 65	S,G	260	Air line	LS	r27.5	5/ /47	PS	ry 307,dd 5,h 24;S 12;L;A;Sn 229.
-17	M. E. Shields	1930	Drl	r 51	51	6	m 51	S,G?	290	--	LS	r41	1930	D	ry 350;Sn 87.
-18	J. E. Peer	1910	Dug-Drl	r137	137	6	m137	S,G?	290	--	LS	r45	--	D	Adequate;Sn 88.
-19	Esso Gas Station	--	Drl	r135	135	6	m135	S	280	--	--	--	--	D	Adequate;Sn 94.
-20	Boston & Maine Railroad Co.	a1895	Dug	r 20	--	72	m 20	S,G	255	--	--	--	--	De	ry 300,h 24;Sn 109.
-21	Town of Rotterdam WD-3	1947	Drl	r110	110	8	m110	Cl	265	--	--	--	--	T,De	L;Sn 228.
-22	W. E. Brown	1946	Drl	r162	162	6	m162	S,G	300	--	LS	r22	6/ /46	D	ry 4;L;Sn 213.
-23	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 46	--	2	m 46	T	329	--	LS	r23	1952	T	L.
-24	do.	1952	Drl	r 57	--	2	m 57	S,G	292	--	LS	r 1	1952	T	L.
-25	do.	1905	Drl	r 80	--	--	m 80	Cl	226	--	--	--	--	T	L.
252-403-1	R. Cheesman	--	Drl	36	36	6	m 36	S,G	250	Top of casing	-4	10.3	6/18/59	D	ry 15.
-2	J. Howgate	--	Dug	29	--	37	m 29	--	250	Top of concrete well cover	LS	17	6/18/59	D	Inadequate in winter.
-3	F. Wilcox	1938	Dug	34	--	20	m 34	S,G	260	Recess for iron well cover	LS	22.1	7/29/59	U	
-4	do.	--	Dug	35	--	24	m 35	S,G	260	Recess for iron well cover	LS	24.6	7/29/59	U	ry 3;A.
252-404-1	L. Cox	1949	Dug	54	--	30	m 54	--	260	Top of concrete well curbing	LS	15	6/18/59	D	Adequate.
253-354-1	A. Sweet	1949	Dvn	r 19	17	1½	m 19	S	350	--	LS	r 8	1949	D	Adequate;S 2.
-2	E. Hess	1949	Dug-Dvn	14	14	24	m 14	T	260	Recess in tile	1.3	12.6	8/ 7/59	D	Inadequate.
-3	A. Joiner	1958	Dug	7	7	22	m 7	T	240	Top of pipe in concrete cover	1.3	6.3	8/ 7/59	D,C	Do.
-4	E. Marks	--	Dug	12	12	20	m 12	T	280	Top of concrete well cover	.2	9.8	8/ 7/59	D	Adequate;A.
-5	H. Williams	1957	Dug	16	--	32	m 16	T	350	Top of brick curbing	.7	11.2	8/ 7/59	D	Do.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
253-354-6	D. Armstrong	1930	Dug	14	--	24	s 14	Sh	360	Recess for well cover	-0.3	14	8/ 7/59	D	Inadequate in summer.
-7	D. Smith	1959	Drl	r130	18	6	18	Sh	350	--	LS	r20	1959	D	ry 0.5,adequate;L.
-8	G. Hoffman	1955	Drl	r 40	40	6	m 40	S	350	--	LS	r10	1955	D	Adequate;H_2S.
-9	J. Fenall	1960	Drl	r105	98	6	98	Sh	350	--	LS	r12	1960	D	ry 5.
253-355-1	Pine Ridge Trailer Court	1959	Dug	10	--	36	m 10	T	370	Top of concrete tile	-2.5	7.2	7/23/59	PS	Adequate.
-2	J. Watson	1953	Dvn	r 15	12	1¼	m 15	S	370	--	LS	r11	1953	D	ry 5;S 3;nearby well 35 ft deep in sand and gravel,water level 11 ft.
-3	G. Zeh	1947	Dug	11	--	55 x 55	m 11	S	360	Recess for well cover	LS	9.2	7/23/59	D	Adequate.
-4	J. Burnett	--	Dug	15	--	24	m 15	T	370	Top of concrete well curbing	LS	11.4	7/23/59	U	Inadequate.
-5	do.	1959	Drl	61	61	4	m 61	S,G	370	Top of casing	-1.3	13.9	7/23/59	D	Adequate.
-6	P. Draper	--	Dug	9	9	24	m 9	S	350	Top of casing	-3.3	9.9	9/17/59	A	
-7	R. Gilchrist	1960	Drl	r 73	73	6	m 73	S	350	--	LS	r 5	1960	D	ry 5.
253-356-1	K. McMehan	--	Dug	17	--	42	m 17	T	420	Recess for well cover	.5	6.7	7/ 9/59	D	Inadequate.
-2	Manlius	1959	Drl	a207	--	6	s207	Sh	410	Top of casing	3.2	23.1	7/ 9/59	T	
253-357-1	A. Cooper	1947	Dug	16	--	36	m 16	T	390	Top of concrete well cover	.5	10.4	7/10/59	D	Inadequate.
-2	W. LaPointe	--	Dug-Dvn	9	--	12-1¼	m 9	S	405	Top of tile	-4	7.5	7/10/59	D	Adequate;H_2S.
-3	J. Dalton	1955	Dug	14	14	36 x 42	m 14	T ?	440	Top of concrete curbing	-3.2	7.8	7/10/59	D	Adequate.
-4	T. Hidding	--	Dug	12	--	72	s 12	Sh	430	Top of iron well cover	LS	5	7/10/59	U	y 6.
253-358-1	Glenville School	1960	Drl	r202	16	6	16	Sh	600	--	--	--	--	In	L.
253-359-1	G. Sommerman	--	Drl	r 42	--	6	1	Sh	800	--	--	--	--	D	ry 12;Sn 21.
253-400-1	J. Gardner	--	Drl	r 90	7	8	7	Sh	770	--	LS	r12	1959	D	ry 4,adequate;H_2S.
253-401-1	H. Galusha	--	Dug	16	--	24	16 ?	Sh ?	620	Top of wooden well cover	.5	6.6	6/12/59	D	Inadequate in summer.
-2	S. Jason	1940	Dug	22	22	48	m 22	T	700	Top of brass air pipe	.3	16.1	6/12/59	D	Adequate.
253-402-1	L. Warner	1929	Dug	7	7	42	7	Sh	370	Top of casing	6	0	6/ 4/59	D	Do.
-2	B. Miller	b1900	Dug	25	--	39	m 25	T	610	Top of wooden well cover	LS	15.1	6/ 9/59	S,A	Do.
-3	C. Hixson	1915	Dug	15	--	36	38	G	270	Rim of well cover	-23	32.4	8/23/45	C	A;T 50;Sn 139.
-4	B. Miller	1955	Aug	r117	85	--	85	Sh	630	--	--	--	--	D	ry 6.5.
253-403-1	Loyd's Motel	1951	Drl	r144	144	6	r247	T	300	--	LS	r48	1959	C	Adequate.
-2	M. Wurz	1955	Drl	r136	136	6	m136	S,G	295	--	LS	r66	1959	D	ry 21,h 24.
-3	B. Fisher	--	Dug	10	--	48	m 10	T	440	Top of wooden well cover	.8	5.1	6/ 3/59	A	Inadequate in summer.
-4	F. Boardman	--	Dug	20	20	30	m 20	T	575	Top of tile	2	11.9	6/ 3/59	D	Adequate.
-5	F. Edwards	--	Dug	7	--	26	m 7	T	735	Top of stone curbing	-3	3.6	6/ 4/59	A	

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
253-403-7	C. Kane	1930	Drl	m142	142	8	142	Sh	300	--	LS	r42 ?	1930	D,S	Adequate;L;Sn 90.
-9	Gerrey	1938	Drl	r 82	82	6	m 82	G	300	--	--	r20	1939	D	Adequate;L;Sn 89.
-10	M. Smith	1938	Dug	r 32	32	48	m 32	S	270	--	LS	r10	1945	D	Adequate;Sn 91.
-11	A. Remington	1931	Drl	r192	192	6	m192	S,G	300	--	LS	r22	1931	D	ry 60;L;Sn 92.
-12	"Aunt Sophia's Grill"	--	Drl	r150	150	6	m150	S,G	300	--	LS	r70	1945	C	Adequate;L;Sn 96.
253-404-1	H. McDougall	--	Dug	15	15	24	m 15	S,G	250	Top of tile	LS	12.6	5/27/59	D	Adequate.
-2	do.	a1920	Drl	28	28	6	m 28	S,G	260	Top of casing	-4	9.4	5/27/59	D	Adequate for three families.
-3	M. Freer	1932	Dug	13	13	12	m 13	S,G	260	Top of tile	LS	9.3	5/27/59	D	Inadequate in summer;Sn 105.
-4	R. Jones	1956	Dug	16	16	48	m 16	S,G	350	Top of 1½-inch pipe	2.8	13.2	5/27/59	D	Inadequate in summer.
-5	J. Swert	1922	Drl	r130	--	8	6	Ls	360	Floor of pumphouse	LS	r90	6/ 1/59	D	ry 2.5,ddsl.
-6	R. Schultz	1953	Dug	5	--	60 x 60	m 5	S	340	--	LS	3.8	6/ 1/59	D	Inadequate in summer.
-7	do.	1949	Dug	3	--	48	m 3	S	350	--	LS	2	6/ 1/59	A	
-8	H. Hatcher	--	Dug	5	5	60 x 84	m 5	T	320	Top of concrete curbing	LS	1.4	6/ 1/59	D	Adequate for six families.
-9	R. Van Eps	--	Dug	r 7	7	42	m 7	S,G	270	--	LS	r 4.5	1959	D	Adequate.
-10	R. Freer	1951	Dug	8	8	24	m 8	S,G	250	Top of pump support	2.9	3.8	6/18/59	D	Inadequate in summer;H_2S.
-11	A. Ryder	1946	Dug	28	28	36	m 28	G	250	Top of wooden well cover	-5.5	16.6	6/18/59	D	Adequate.
-12	G. Disorbo	1941	Drl	r133	--	6	m133	G	340	--	LS	r40	1941	D	Adequate;L;A;Sn 93.
-13	N.Y.S. Dept. of Pub. Wks.	1952	Drl	r 67	--	2	m 67	T	273	--	LS	r20	1952	T	L.
-14	do.	1952	Drl	r 77	--	2	m 77	T	275	--	LS	r12	1952	T	L.
-15	do.	1952	Drl	r 59	--	2	m 59	G	331	--	LS	r21	1952	T	L.
-16	do.	1952	Drl	r 77	--	2	m 77	S,Si	330	--	LS	r11	1952	T	L.
-17	do.	1952	Drl	r 62	--	2	m 62	S,G	326	--	LS	r25	1952	T	L.
253-405-2	I. McAuley	a1910	Dug	r 19	19	24	m 19	T	260	--	LS	r10	1945	D,S	Adequate;Sn 108.
254-354-1	W. Ille	1957	Drl	r 54	50	6	50	Sh	390	--	--	--	--	D	ry 10;L;H_2S.
-2	J. Shaeffer	--	Dug	14	--	36	m 14	S	380	Top of concrete well cover	LS	12.7	9/17/59	D	Adequate.
-3	A. W. Germer	1951	Dug	16	16	48	m 16	T	400	Top of cinder block curbing	.4	13.7	9/17/59	D	Inadequate;A.
-4	do.	1950	Drl	r285	--	6	--	Sh	400	Top of well cover	-5.2	40.2	9/17/59	D	Inadequate.
-5	Tanner's Liquor Store	1960	Drl	r212	11	6	11	Sh	370	Top of casing	-3.2	3.7	5/10/61	C	Adequate.
-6	Stewart's Ice Cream	1960	Drl	r183	19	6	19	Sh	370	--	--	--	--	C	Do.
-7	P. G. Bell	1944	Drl	r200	18	8	18	Sh	400	--	LS	r22	1944	D	y 2,dd 173,h 0.33;L;Sn 217.
254-355-1	S. Dehlin	b1900	Dug	13	--	24	m 13	S	390	Bottom of concrete well cover	LS	11	7/24/59	D	Adequate.
-2	K. Van Vorst	b1900	Dug	23	--	30	m 23	S,Si	340	Top of concrete well cover	LS	18.8	7/24/59	D	Inadequate.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
254-355-3	E. Freeman	1951	Drl	113	113	6	m113	T or Cl	360	Top of casing	-6	22.3	7/24/59	D	ry 7.
-4	A. Young	1956	Drl	r 65	65	6	m 65	S,G	350	--	--	--	--	D	ry 3;casing perforated between 43-45 ft;L.
-5	F. Rodgers	--	Dug	--	--	24	--	Si	340	--	LS	Flowing	9/17/59	D	Flowing y 1;A;T 50;developed spring.
-6	Burton	--	Drl	r 80	60	6	60	Sh	340	--	--	--	--	D	y 3;Sn 17.
254-359-1	R. Carter	1946	Drl	r 65	12	8	12	Sh	685	--	LS	r 2	2/ /46	D	y 1,dd 63,h 0.25;L;Sn 187.
254-400-1	K. Powell	1941	Dug	13	--	72	3	Sh	850	Bottom of ties covering well	LS	4	6/11/59	D	Usually adequate.
-2	M. P. Hale	1954	Dug	16	3	24	8	Sh	915	Top of tile	-4.5	8.5	6/12/59	D	Adequate.
254-401-1	I. Kowalski	--	Dug	25	--	32	s 25	Sh,T	790	Top of wooden cover	.3	13.6	6/ 9/59	D	Do.
-2	J. Merritt	1951	Dug	13	--	36	--	Sh	960	Top of tile	2.8	3.6	6/11/59	A	
254-402-1	---	--	Dug	9	8	22-48	8	Sh	950	Top of concrete curbing	.4	5.1	6/ 9/59	A	
-2	R. Nicoll	--	Dug	14	--	18-30	s 14	Sh	945	Top of concrete curbing	.6	5.7	6/ 9/59	D	Adequate.
-3	F. Williams	--	Dug	8	--	30	s 8	Sh	1,020	Top of wooden curbing	2.2	1.7	6/ 9/59	U	
254-403-1	F. Graham	--	Dug	14	--	36	m 14	T	840	Top of wooden cover	LS	8.9	6/ 4/59	A	
-2	A. L. Sayles	1955	Drl	101	--	6	s101	Sh	865	Top of steel casing	.4	9.2	6/ 4/59	A	ry 2.
-3	B. Van Flue	--	Dug	11	--	36	2	Sh	1,010	Top of tile curbing	2.6	5.2	6/10/59	S	Adequate.
254-404-1	R. Schultz	1924	Dug	3	3	99 x 144	3	Sh	450	Top of concrete cover	LS	1.9	6/ 1/59	D	Do.
-2	H. W. Morris	1906	Dug	4	--	30	m 4	T	660	--	LS	Dry	6/25/46	D,S	Usually adequate;Sn 197.
-3	F. A. Wiegleb	a1900	Dug-Drl	12-75	--	48-6	s 10	Sh	700	Top of concrete slab	LS	5.8-20.5	6/25/46	D	Adequate;Sn 198.
255-359-1	Clark	1957	Drl	r316	2	8	2	Sh	630	Top of casing	1.5	r33.5	1/ /57	D	ry 2;H_2S.
-2	do.	1958	Drl	r164	2	6	2	Sh	630	Top of casing	1	r34	1958	D	Adequate;H_2S.
255-401-1	H. Campbell	1944	Drl	66	17	8	17	Sh	650	Top of casing	-3	30	6/11/59	D	Adequate.
-2	P. Pierson	1939	Dug	22	12	30 x 48	3	Sh	665	Top of concrete casing	LS	18.1	6/11/59	D,S	Do.
-3	H. Moore	1940	Dug	r 11	11	12	m 11	G	510	--	LS	4	1946	D	Adequate;Sn 206.
-4	M. Yager	b1900	Dug	12	--	48	m 12	S	520	Top of concrete slab	-5	5.9	6/26/46	D	Adequate;A;Sn 205.
255-402-1	W. Tacowski	b1900	Dug	20	--	36	20	Sh	720	Concrete well cover	1	7.4	6/10/59	D	Adequate.
-2	A. Gontko	a1900	Dug	4	--	29	4	Sh	650	Top of lowest part of top of stone curbing	1.6	1.6	6/10/59	D	Do.
255-403-1	G. Bentley	1933	Dug-Drl	r120	--	36-6	--	Sh	700	Top of concrete cover	.6	5.8	6/10/59	D,S	Do.
-2	C. Seaward	1954	Dug	13	--	52	0	Sh	720	Top of wooden cover	-5.5	11.9	6/10/59	D	Do.
-3	R. Guard	b1900	Dug	18	18	24	m 18	S,G	730	Top of tile	.5	13.9	6/10/59	D	Do.
255-404-1	M. Kinnan	1945	Drl	91	--	6	s 10	Ls	740	Top of brick curbing	.3	14.1	6/10/59	D,S	Do.
-2	W. Parker	1946	Dug-Drl	r 74	--	38-6	10	Ls	750	Bottom of wooden cover	LS	12.4	6/11/59	D	Adequate;H_2S.
-3	B. Hartman	1944	Drl	72	--	8	s 10	Ls	770	Top of casing	2	10.2	6/26/46	S	Adequate;Sn 201.

Table 9.--Records of selected wells and test holes in eastern Schenectady County (Continued)

Well number	Owner	Year completed	Type of well	Depth of well (feet)	Depth of casing (feet)	Diameter of well (inches)	Depth to bedrock (feet)	Water-bearing material	Altitude above sea level (feet)	Measuring point: Description	Measuring point: Position	Water level: Depth below land surface (feet)	Water level: Date	Use	Remarks
255-404-4	V. De Graff	a1900	Dug	18	--	48	3	Sh	725	Top of wooden cover	0.5	9	6/26/45	D	Adequate;A;T 46;Sn 199.
255-405-1	H. Tatlock	b1900	Dug	5	--	60	5	Ls	700	Top of wooden cover	1.2	1	6/11/59	S	Adequate.
256-403-1	N. Smith	b1900	Dug	r 42	--	48	42	S,G	720	--	LS	r30	6/26/46	D,S	Adequate;Sn 203.
256-405-1	R. Chriss	b1900	Dug	13	--	78 x 54	4	Ls	700	Bottom of wooden cover	LS	3.4	6/11/59	S	Adequate;H_2S.

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An asterisk (*) indicates that the report is out of print, but such reports are available for consultation in certain libraries.

BULLETINS:

*GW- 1 WITHDRAWAL OF GROUND WATER ON LONG ISLAND, N. Y.
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*GW- 2 ENGINEERING REPORT ON THE WATER SUPPLIES OF LONG ISLAND.
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*GW- 5 RECORD OF WELLS IN NASSAU COUNTY, N. Y.
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